PROYECTO FIN DE CARRERA:

PROYECTO DE INSTALACIÓN DE AIRE COMPRIMIDO

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1. RESUMEN

RENAULT, debido a últimas adjudicaciones derivadas a la planta de Valladolid ha decidido que para hacer frente a la nueva demanda debe adquirir una línea de aire comprimido más eficiente y moderna de la que posee para su sala de pintura y retoque.

Pese a contar con el diseño de la tubería por parte de una prestigiosa Ingeniería, EA (Empresarios Agrupados), Ingersoll Rand, para garantizar el buen funcionamiento de sus equipos lleva a cabo un segundo calculo en el diseño de las tuberías que corroboren los previamente llevados a cabo por EA. Para ello, basándonos en la ecuación de Darcy hemos hallado la pérdida de carga en los distintos tramos de tubería verificando la buena operabilidad de la instalación en función de los parámetros y planos solicitados por el cliente. Obteniendo una perdida de carga de 0.18 bar podemos asegurar que cumplimos con los mínimos requisitos exigidos.

Posteriormente, Ingersoll, mediante un programa de cálculo propio, basado en interpolaciones, propone una solución distinta a la planteada por el cliente: la instalación de un compresor de velocidad variable que permitirá unos ahorros energéticos estimados de 24.500 €/año. A través de una auditoría energética con la ayuda del citado programa (Intellisurvey) Ingersoll llevará a cabo la instalación de su máquina más eficiente: El compresor NIRVANA, de tecnología ultramoderna con un motor de velocidad variable.

Con este proyecto, por tanto, lo que se pretende es mostrar el proceso de entrega de una instalación llave en mano de aire comprimido desde un punto de vista empresarial y en especial demostrar la necesidad y utilidad de análizar las líneas de aire comprimido existentes España que permiten un gran ahorro tanto a nivel energético, como económico, como desde el punto de vista ambiental.

2. INTRODUCCION

2. Descripción general del proyecto

2.1 Objeto:

El objeto principal del proyecto es el diseño e instalación de una sala de compresores, previamente construida, para proporcionar aire comprimido para la red de instrumentos de la misma.

A consecuencia del aumento de producción en un nuevo modelo de Renault, el Espace, la fábrica de Renault en Valladolid precisa de un aumento en la producción de aire comprimido para una nueva sección dedicada a postproducción. Dicha sala es vital en el proceso de fabricación, ya que la nueva maquinaria adaptada a las calidades exigidas requiere de una precisión óptima. Por su versatilidad, diversidad, potencia y robustez la maquinaria elegida a tal uso será de accionamiento neumático. Por este motivo, al ser impulsadas con aire comprimido es fundamental el buen funcionamiento en la sala de aire comprimido.

Por ello, Ingersoll Rand se compromete a diseñar una sala de compresores innovadora, eficiente y acorde a las exigencias del cliente.

2.2 Alcance de la instalación:

La instalación estará dimensionada para cubrir la máxima demanda de aire posible por parte de la instrumentación que se debe alimentar neumáticamente.

Por exigencias del cliente y la disponibilidad de una sala existente los equipos a alimentar encuentran a una distancia aproximada de unos 100 a 200 metros de la sala de compresión.

Los equipos a utilizar para el servicio de aire comprimido serán los siguientes:

- 2 Compresores con capacidad del 100% de caudal cada uno
- 2 Secadores de adsorción para tratamiento de aire del 100% de caudal cada uno, cubriendo así la posibilidad de funcionar con cualquiera de los dos.
- Conjunto de filtración para evitar el paso de partículas sólidas desde el compresor al secador y desde el secador de adsorción a los útiles
- Depósito pulmón para amortiguación de vibraciones posibles debido a los cambios en la demanda, y garantía de una autonomía suficiente para parada de equipos críticos en caso de fallo de los equipos de compresión o supervisión de los mismos.
- Purgas de condensados para filtros y depósito pulmón neumáticas.
- Dispositivo X8i para control de los compresores

2.2.1. Instalaciones y servicios a realizar por parte de Ingersoll Rand.

- Conexiones mecánicas entre equipos y conexiones mecánicas entre colectores finales para instrumentos y los equipos de generación de aire comprimido
- Derivación de condensados a un punto común
- Cuadros de potencia y control. Subcontratado.
- Derivación de condesados a una arqueta para su posterior procesado
- Puesta en marcha de los equipos
- Auditoría energética tras haber instalado y probado los equipos

2.2.2. Instalaciones y servicios excluidas por parte de Ingersoll Rand.

- Conexión eléctrica entre equipos.
- Conexiones y aprovisionamiento de agua para refrigeración de los equipos. Limite de batería en la brida de entrada del agua.

La clase de aire requerida para la alimentación de los equipos tendrá las siguientes características:

- Clase 0
- -40º C de punto rocío garantizado
- Caudal máximo garantizado
- Presión de trabajo mínima en punto más alejado 7 barg

2.3 Reglamentación específica:

En la realización del siguiente proyecto se han aplicado las siguientes normas específicas:

- Normativa específica para este proyecto de Empresarios Agrupados para selección de máquinas, instalación mecánica e instalación eléctrica.

2.4 Situación y emplazamiento:

Emplazamiento:

La nave de fabricación de Renault está situada en:

- Calle Fabrica Renault nº1, Valladolid.

La sala de compresores estará situada anexa a la nave de fabricación. Se encuentra a una distancia de la nave de fabricación 10 metros desde la pared exterior.

2.4.1. Valores Climatológicos Normales. Valladolid:

Medias y totales anuales 2010.

Para la realización de los cálculos de las medias anuales se han utilizado datos de 365 días (100% del año).

Datos	Valor	Días computados
Temperatura media anual:	**12.1°C**	365
Temperatura máxima media anual:	**18.3°C**	365
Temperatura mínima media anual:	**7.1°C**	365
Humedad media anual:	**67%**	363
Precipitación total acumulada anual:	**544.83 mm**	365
Visibilidad media anual:	**17.3 Km**	365
Velocidad del viento media anual:	**9.3 km/h**	365

Para calcular la temperatura media se han analizado 2899 mediciones.
Para calcular la velocidad media del viento se han analizado 2898 mediciones.

	T	TM	Tm	SLP	H	PP	VV	V	VM	Vg	RA	SN	TS	FG
enero	4	7.6	1.5	1016	83.9	75.45	14.6	10.5	16.7		14	3	0	4
febrero	4.2	8.8	1.1	1008.2	79.8	56.12	15.3	10.2	18.2		15	2	0	1
marzo	7.1	12.6	3.1	1016.9	70.5	53.6	15.9	10.7	17.8		18	1	0	2
abril	12.1	18.7	6.4	1015.7	67.1	62.99	18	8.2	13.3		9	0	4	2
mayo	13.5	20.2	7.6	1014.9	63.2	35.31	19	9.4	14.6		10	0	0	0
junio	18.3	25.4	12.2	1013.3	61.8	47.5	20	9.1	14.3		9	0	2	0
julio	23.5	32.3	15.7	1014.4	47.1	9.65	20	9.1	14.1		3	0	2	0
agosto	22.6	30.9	15	1014.6	43.7	0	20.2	9.8	15		0	0	0	0
septiembre	18.1	25.7	12	1014.9	55.5	12.96	19.7	8.1	14.3		6	0	0	0
octubre	11.8	18.6	6.6	1013.6	66	44.19	17	8.2	13.8		6	0	1	0
noviembre	6.2	10.8	3	1013.9	82.7	32.76	14	10.6	16.7		7	2	0	6
diciembre	3.8	7.9	0.8	1014.1	83.9	114.3	13.9	7.8	12		13	1	0	4

T- Temperatura media (ºC)

TM- Temperatura máxima (ºC)

Tm- Temperatura mínima (ºC)

SLP-Presión atmosférica a nivel del mar (mb)

H- Humedad relativa media (%)

PP-Precipitación total de lluvia o nieve derretida (mm)

VV-Visibilidad media (km)

V-Velocidad media del viento (km/h)

VM-Velocidad máxima sostenida del viento (km/h)

Vg-Velocidad de ráfagas máximas de viento

RA-Índice si hubo lluvia o llovizna

SN-Índice si nevó

TS-Índice si hubo tormenta

FG-Indice si hubo niebla

2.5 Instalaciones contempladas

2.5.1 Aire comprimido e instalación mecánica

2.5.1.1 Objeto

El objeto de este apartado es describir la instalación de producción y distribución de aire comprimido para la nueva instalación que RENAULT va a construir en Valladolid.
Esta instalación se realizará de acuerdo con todas las prescripciones de los reglamentos y normas en vigor a este efecto.

2.5.1.2 Normativa aplicable

- Reglamento de aparatos a presión del Ministerio de Industria y Energía.
- Normas UNE de aplicación.
- Especificaciones de EA, donde apliquen.

2.5.1.3 Descripción

Se ha dispuesto de una distribución de aire comprimido se realizará a través de dos anillos en serie, uno para la sala de pintura y otra para la sala de retoques. Estos anillos están unidos por una tubería que será capaz de proporcionar el caudal necesario a la sala de pintura sin causar excesivas pérdidas. Además la tubería principal está diseñada de tal manera que pueda hacer una ampliación sin tener que modificar la instalación diseñada, pues contará con tomas selladas para un posible futuro uso.

La red de distribución se realizará en tubería de acero estirado sin soldadura según Norma DIN 2440, para el ramal de mantenimiento y tomas rápidas.

Se dispondrá a lo largo del recorrido de soportes sólidos y adecuados a la normativa vigente y a las condiciones de trabajo de la red de suministro. Los elementos de unión, conexión o derivación de las conducciones deberán ser soldados acordes con la su normativa correspondiente y las condiciones de estanqueidad y presión a las que se compromete el suministro y siguiendo los detalles que aparecen en los planos.

La red se sectorizará con válvulas de corte situadas según el plano anexo a este documento, y se dispondrán tapones en los pasos por pilares en previsión de una posible ampliación.

La producción de aire comprimido se realiza a través de un compresor de caudal fijo y presión de trabajo de 8.5 bar, más uno de reserva con las mismas características, ambos situados en la sala de compresores, anexa a la nave.

Los compresores aspiran aire a presión atmosférica, y lo comprimen a una presión de 8.5 bares como máximo. El punto de trabajo de los compresores será en torno a este punto.

2.5.1.4 Diseño de la instalación

- Se instalarán dos compresores más uno de reserva para tener un funcionamiento redundante de un 15 % de la demanda prevista, en torno a 24,6 m3/min.

- Se dispondrá de dos secadores trabajando en paralelo, para dar servicio a la demanda máxima prevista. Dichos secadores serán de regeneración por aire comprimido, lo que para determinar el compresor necesitaremos un 15-20% más de caudal.

- Cada secador dispondrá de sendos filtros externos, uno previo de 10 micras y post-filtro de 0’01 micras.

- Previo a la salida a los anillos, se dispondrá de un depósito con una capacidad de 6000 litros.

- Se dispondrá de un circuito de condensados que confluirá en una arqueta para ser derivada a su zona de tratamiento de condensados, mediante tubo de TEKALAN, transparente, que permita ver el fluido y será vertido al sistema ACO drain de recogida de condensados.

- Anillos perimetrales a las dos zonas diferenciadas de la nave, distribuyendo el conjunto de tomas

- Cada toma de conexión a maquinaria llevará una purga automática.

- La presión de servicio en la salida de los compresores se establecerá a 7 bares más las pérdidas del circuito, con una banda de presión de funcionamiento aceptable de 0.5 bares.

- Se instalarán enchufes rápidos.

- Las tuberías horizontales tendrán pendiente de 0.5% y las de derivación a ramales también tendrán una pendiente del 0,5% con el fin de que los condensados se eliminen.

- En las esquinas de cada uno de los anillos se dispondrán purgadores automáticos, exceptuando los dos primeros codos del anillo principal (TOMA A1 y A2)

- Se dispondrá de liras o dilatadores cuando la longitud de las tuberías tengan un trazado recto superior a una longitud de 60m.

A petición de EA, no se instalarán tuberías con diámetros inferiores ½", debido a que las tuberías demasiado pequeñas causan altas velocidades de circulación de aire, haciendo difícil la separación por métodos mecánicos de las partículas contaminantes en suspensión. Aunque se instalarán boquillas de ½" para los colectores de uso.

La producción de aire comprimido se realizará principalmente para suministro a útiles, herramientas neumáticas y tomas auxiliares para limpieza.

Además, se conducirá aire comprimido a diferentes puntos de consumo de la nave para diversas aplicaciones.

Toda la instrumentación de corte necesaria, soportes, purgadores, reguladores de presión, tomas rápidas y colectores se instalarán según el plano adjunto de la sala de retoque.
Adicionalmente para el sistema de control de presión se instalarán manómetros diferenciales en puntos clave de la red de aire comprimido para el control de los compresores.

Los huecos realizados en la pared para atravesar con la tubería, serán sellados o con silicona o con espuma de poliuretano con el fin de garantizar que no se dañe la tubería e independizar una sala de otra (esto es crítico en la sala de pintura).

2.5.1.5 Consumos considerados

La relación de consumos considerado para el dimensionamiento y diseño de la red de aire comprimido que se expone a continuación se determina en función de las demandas de las máquinas y equipos a disponer en la nueva Sala:

A estos valores hay que sumarles un 20% de pérdida de aire comprimido para

Conexión	Útil de esa toma con consumo máximo	Número útiles	Consumo máximo unitario (m3/min)	Consumo máximo simultáneo (m3/min)	Factor de simultaneidad y utilidad	Total (m3/min)
Toma rápida	Servicios de limpieza	4	1,8	7,2	0,6	4,32
Toma rápida	Remachadoras	4	0,84	3,36	0,6	2,016
Toma rápida	Lijadoras	2	0,59	1,18	0,8	0,944
Toma rápida	Laves de impacto	4	1,1	4,4	0,5	2,2
Toma rápida	Atornilladores varios	4	0,7	2,8	0,7	1,96
Toma fija	Pistolas de pintura	4	1,5	6	0,6	3,6
Toma fija	Elevadores neumáticos	2	3,1	6,2	0,3	1,86
						16,9
Factor de sobredimensionamiento por previsión de pérdidas						1,15
						19,435

regeneración de los secadores de aire comprimido. Esto nos da un valor total de 23,322 m3/min necesarios, que no superan la capacidad de un compresor de 24,6 m3/min.

Se instalará además un depósito presurizado, con la presión requerida, de 6000 l conectado al colector de la nave para la estabilización de la alimentación del aire, compensando las caídas de presión en la red debidas a consumos puntuales de aire que no requieran la totalidad del caudal producido por uno de los compresores.

De este modo, mientras el compresor se encuentra operativo, en carga, el depósito de aire comprimido comienza a llenarse de forma que tan pronto se alcanza la presión fijada en el circuito de suministro, se desconectan los compresores. Si debido a la demanda de consumo, la presión disminuye, por el consumo paulatino del aire de los depósitos, arrancan los compresores de nuevo ahorrándose así una gran cantidad de energía y dinero.

Gracias a la gran superficie de los depósitos de aire comprimido, se enfría el aire adicionalmente, con lo que se separa directamente en el depósito una fracción de la humedad del aire en forma de agua, evacuada a través de purgas.

El paquete de los equipos de secado, por adsorción, viene equipado con un bypass adicional para utilizar en caso de mantenimiento del secador , por lo que el aire continua pasando por los filtros. De esta forma, en caso de necesidad urgente de aire se dispondrá del mismo . Dicho aire no estará seco pero al menos estará limpio.

2.5.2 Inslatación eléctrica y electrónica

2.5.2.1 Objeto

La instalación eléctrica será necesaria para la alimentación eléctrica de todos los equipos eléctricos de la sala de compresores a realizar y para protección de los operarios y de las propias máquinas de las incidencias que puedan ocurrir.

2.5.2.2 Normativa aplicable

Las normativas aplicables en términos de electricidad serán las siguientes:

- REBT, puesto que la alimentación eléctrica será de 400V/3f/50 Hz y 230/1f/50 Hz. No hay requerimientos adicionales por no ser área clasificada.
- Especificaciones eléctricas de Empresarios Agrupados.
- Normativa local vigente.

2.5.2.3 Descripción general

Se pretende alimentar los equipos eléctricos desde dos armarios, uno de potencia y otro de control.

El armario de potencia alimentará a los equipos de compresión y los secadores de adsorción, mientras que desde el otro cuadro se alimentará el controlador X8i.

Dicha instalación será subcontratada exteriormente siguiendo las especificaciones de EA.

2.5.2.4 Control y filosofía de los equipos.-X8i-

El funcionamiento de los equipos será el siguiente:

- Un compresor será el primario y el que funcione alternativamente mientras que el otro compresor será el que esté en reserva a la espera en modo re-arranque automático (PORO) para en el caso de que sea necesario este compresor entre también en carga. Al estar los secadores cada uno de ellos dimensionados al 100% para los dos compresores, no habrá problema de tratamiento de aire ni problema en garantizar los -40º C de punto de rocío.

- Según petición del cliente, se necesita que ambos compresores se alternen para llevar trabajadas el mimo número de horas, aquí es donde entra la funcionalidad del X8i que es capaz a través de comunicación MODBUS entre los equipos de controlarlos mediante un algoritmo para que los compresores se alternen trabajando las mismas horas. También es capaz de controlar los secadores de adsorción con el mismo fin.

- Aparte de estas funciones del X8i, a través de la pasarela Gateway se puede comunicar con el DCS y desde éste tener acceso a parámetros de cada equipo en tiempo real mediante la implementación de un programa para control de dichos parámetros, éste es configurado con los registros de cada compresor al que se le asigna una dirección. Cada señal tiene un registro de donde se extrae la información.

- No obstante, se requiere redundancia de señales por riesgo de fallo, con lo que de cada equipo salen diferentes señales cableadas directamente al DCS para control. Estas señales pueden ser:
    - Señales libres de potencial
    - Señales 4-20 mA

Estas señales se podrán extraer de un bornero desde el armario de control para disposición del cliente.

2.5.2.5 Previsión de cargas

Para estimar la previsión de cargas del conjunto de los equipos contamos con la hoja de características de cada equipo que nos permitirá, junto con el proveedor seleccionado llevar a cabo la instalación eléctrica, así como inicialmente indicar al cliente la potencia que debe contratar para que la línea funcione correctamente.

Como estamos tratando con una potencia de elevado valor, evidentemente tendremos que contar con una línea trifásica que soporte dichos equipos sin riesgo de caída.

2.5.3 Red de agua de condensados

La red de aguas de condensados recogerá el agua procedente de los equipos.

2.5.4 Instalación de agua de refrigeración

Fuera del alcance de IR.

2.6 Auditoría Energética

2.6.1 Introduccion

La finalidad de la auditoría energética consiste en proponer mejoras debido al mal dimensionamiento o funcionamiento de la planta inicialmente prevista.

2.6.2 Procedimiento

Toma de medidas y redaccion de informe a traves del programa Intellysurvey 3.2 propiedad intelectual de Ingersoll Rand basado en interpolacion de multitud de resultados.

2.6.3 Estudio económico

Finalmente, con los datos recogidos en el estudio energético se llevará a cabo la tarea más difícil de todas las que nos encontramos. Hacer ver al cliente la necesidad y conveniencia de invertir una cantidad de dinero que redundará en su beneficio.

3. DESCRIPCION GENERAL

3.1Instalaciones contempladas

3.1.1Aire comprimido e instalación mecánica

3.1.1.1 Objeto

El objeto de este apartado es describir la instalación de producción y distribución de aire comprimido para la nueva instalación que RENAULT va a construir en Valladolid.
Esta instalación se realizará de acuerdo con todas las prescripciones de los reglamentos y normas en vigor a este efecto.

3.1.1.2 Normativa aplicable

- Reglamento de aparatos a presión del Ministerio de Industria y Energía.
- Normas UNE de aplicación.
- Especificaciones de EA, donde apliquen.

3.1.1.3 Descripción

Se ha dispuesto de una distribución de aire comprimido se realizará a través de dos anillos en serie, uno para la sala de pintura y otra para la sala de retoques. Estos anillos están unidos por una tubería que será capaz de proporcionar el caudal necesario a la sala de pintura sin causar excesivas pérdidas. Además la tubería principal está diseñada de tal manera que pueda hacer una ampliación sin tener que modificar la instalación diseñada, pues contará con tomas selladas para un posible futuro uso.

La red de distribución se realizará en tubería de acero estirado sin soldadura según Norma DIN 2440, para el ramal de mantenimiento y tomas rápidas.

Se dispondrá a lo largo del recorrido de soportes sólidos y adecuados a la normativa vigente y a las condiciones de trabajo de la red de suministro. Los elementos de unión, conexión o derivación de las conducciones deberán ser soldados acordes con la
su normativa correspondiente y las condiciones de estanqueidad y presión a las que se compromete el suministro y siguiendo los detalles que aparecen en los planos.

La red se sectorizará con válvulas de corte situadas según el plano anexo a este documento, y se dispondrán tapones en los pasos por pilares en previsión de una posible ampliación.

La producción de aire comprimido se realiza a través de un compresor de caudal fijo y presión de trabajo de **8.5 bar**, más uno de reserva con las mismas características, ambos situados en la sala de compresores, anexa a la nave.

Los compresores aspiran aire a presión atmosférica, y lo comprimen a una presión de 8.5 bares como máximo. El punto de trabajo de los compresores será en torno a este punto.

3.1.1.4 Diseño de la instalación

- Se instalarán dos compresores más uno de reserva para tener un funcionamiento redundante de un 15 % de la demanda prevista, en torno a 24,6 m3/min.

- Se dispondrá de dos secadores trabajando en paralelo, para dar servicio a la demanda máxima prevista. Dichos secadores serán de regeneración por aire comprimido, lo que para determinar el compresor necesitaremos un 15-20% más de caudal.

- Cada secador dispondrá de sendos filtros externos, uno previo de 10 micras y post-filtro de 0’01 micras.

- Previo a la salida a los anillos, se dispondrá de un depósito con una capacidad de 6000 litros.

- Se dispondrá de un circuito de condensados que confluirá en una arqueta para ser derivada a su zona de tratamiento de condensados, mediante tubo de TEKALAN, transparente, que permita ver el fluido y será vertido al sistema ACO drain de recogida de condensados.

- Anillos perimetrales a las dos zonas diferenciadas de la nave, distribuyendo el conjunto de tomas
- Cada toma de conexión a maquinaria llevará una purga automática.

- La presión de servicio en la salida de los compresores se establecerá a 7 bares más las pérdidas del circuito, con una banda de presión de funcionamiento aceptable de 0.5 bares.
- Se instalarán enchufes rápidos.
- Las tuberías horizontales tendrán pendiente de 0.5% y las de derivación a ramales también tendrán una pendiente del 0,5% con el fin de que los condensados se eliminen.
- En las esquinas de cada uno de los anillos se dispondrán purgadores automáticos, exceptuando los dos primeros codos del anillo principal (TOMA A1 y A2)
- Se dispondrá de liras o dilatadores cuando la longitud de las tuberías tengan un trazado recto superior a una longitud de 60m.

A petición de EA, no se instalarán tuberías con diámetros inferiores ½", debido a que las tuberías demasiado pequeñas causan altas velocidades de circulación de aire, haciendo difícil la separación por métodos mecánicos de las partículas contaminantes en suspensión. Aunque se instalarán boquillas de ½" para los colectores de uso.

La producción de aire comprimido se realizará principalmente para suministro a útiles, herramientas neumáticas y tomas auxiliares para limpieza.

Además, se conducirá aire comprimido a diferentes puntos de consumo de la nave para diversas aplicaciones.
Toda la instrumentación de corte necesaria, soportes, purgadores, reguladores de presión, tomas rápidas y colectores se instalarán según el plano adjunto de la sala de retoque.

Adicionalmente para el sistema de control de presión se instalarán manómetros diferenciales en puntos clave de la red de aire comprimido para el control de los compresores.

Los huecos realizados en la pared para atravesar con la tubería, serán sellados o con silicona o con espuma de poliuretano con el fin de garantizar que no se dañe la tubería e independizar una sala de otra (esto es crítico en la sala de pintura).

Conexión	Útil de esa toma con consumo máximo	Número útiles	Consumo máximo unitario (m3/min)	Consumo máximo simultáneo (m3/min)	Factor de simultaneidad y utilidad	Total (m3/min)
Toma rápida	Servicios de limpieza	4	1,8	7,2	0,6	4,32
Toma rápida	Remachadoras	4	0,84	3,36	0,6	2,016
Toma rápida	Lijadoras	2	0,59	1,18	0,8	0,944
Toma rápida	Laves de impacto	4	1,1	4,4	0,5	2,2
Toma rápida	Atornilladores varios	4	0,7	2,8	0,7	1,96
Toma fija	Pistolas de pintura	4	1,5	6	0,6	3,6
Toma fija	Elevadores neumáticos	2	3,1	6,2	0,3	1,86
						16,9
Factor de sobredimensionamiento por previsión de pérdidas						1,15
						19,435

3.1.1.5 Consumos considerados

La relación de consumos considerado para el dimensionamiento y diseño de la red de aire comprimido que se expone a continuación se determina en función de las demandas de las máquinas y equipos a disponer en la nueva Sala:

A estos valores hay que sumarles un 20% de pérdida de aire comprimido para regeneración de los secadores de aire comprimido. Esto nos da un valor total de 23,322 m3/min necesarios, que no superan la capacidad de un compresor de 24,6 m3/min.

Se instalará además un depósito presurizado, con la presión requerida, de 6000 l conectado al colector de la nave para la estabilización de la alimentación del aire, compensando las caídas de presión en la red debidas a consumos puntuales de aire que no requieran la totalidad del caudal producido por uno de los compresores.

De este modo, mientras el compresor se encuentra operativo, en carga, el depósito de aire comprimido comienza a llenarse de forma que tan pronto se alcanza la presión fijada en el circuito de suministro, se desconectan los compresores. Si debido a la demanda de consumo, la presión disminuye, por el consumo paulatino del aire de los depósitos, arrancan los compresores de nuevo ahorrándose así una gran cantidad de energía y dinero.

Gracias a la gran superficie de los depósitos de aire comprimido, se enfría el aire adicionalmente, con lo que se separa directamente en el depósito una fracción de la humedad del aire en forma de agua, evacuada a través de purgas.

El paquete de los equipos de secado, por adsorción, viene equipado con un bypass adicional para utilizar en caso de mantenimiento del secador , por lo que el aire continua pasando por los filtros. De esta forma, en caso de necesidad urgente de aire se dispondrá del mismo . Dicho aire no estará seco pero al menos estará limpio.

3.1.2 Inslatación eléctrica y electrónica

3.1.2.2 Objeto

La instalación eléctrica será necesaria para la alimentación eléctrica de todos los equipos eléctricos de la sala de compresores a realizar y para protección de los operarios y de las propias máquinas de las incidencias que puedan ocurrir.

3.1.2.3 Normativa aplicable

Las normativas aplicables en términos de electricidad serán las siguientes:

- REBT, puesto que la alimentación eléctrica será de 400V/3f/50 Hz y 230/1f/50 Hz. No hay requerimientos adicionales por no ser área clasificada.
- Especificaciones eléctricas de Empresarios Agrupados.
- Normativa local vigente.

3.1.2.4 Descripción general

Se pretende alimentar los equipos eléctricos desde dos armarios, uno de potencia y otro de control.

El armario de potencia alimentará a los equipos de compresión y los secadores de adsorción, mientras que desde el otro cuadro se alimentará el controlador X8i.

Dicha instalación será subcontratada exteriormente siguiendo las especificaciones de EA.

3.1.2.5 Control y filosofía de los equipos.-X8i-

El funcionamiento de los equipos será el siguiente:

- Un compresor será el primario y el que funcione alternativamente mientras que el otro compresor será el que esté en reserva a la espera en modo re-arranque automático (PORO) para en el caso de que sea necesario este compresor entre también en carga. Al estar los secadores cada uno de ellos dimensionados al 100% para los dos compresores, no habrá problema de tratamiento de aire ni problema en garantizar los -40º C de punto de rocío.

- Según petición del cliente, se necesita que ambos compresores se alternen para llevar trabajadas el mimo número de horas, aquí es donde entra la funcionalidad del X8i que es capaz a través de comunicación MODBUS entre los equipos de controlarlos mediante un algoritmo para que los compresores se alternen trabajando las mismas horas. También es capaz de controlar los secadores de adsorción con el mismo fin.

- Aparte de estas funciones del X8i, a través de la pasarela Gateway se puede comunicar con el DCS y desde éste tener acceso a parámetros de cada equipo en

tiempo real mediante la implementación de un programa para control de dichos parámetros, éste es configurado con los registros de cada compresor al que se le asigna una dirección. Cada señal tiene un registro de donde se extrae la información.

- No obstante, se requiere redundancia de señales por riesgo de fallo, con lo que de cada equipo salen diferentes señales cableadas directamente al DCS para control. Estas señales pueden ser:
    - Señales libres de potencial
    - Señales 4-20 mA

Estas señales se podrán extraer de un bornero desde el armario de control para disposición del cliente.

3.1.2.6 Previsión de cargas

LISTA DE CONSUMIDORES ELÉCTRICOS										
EQUIPO	**Voltaje (V)**	**Potencia max (kW)**	**COS fi**	**Potencia aparente (kVA)**	**Iarr/ In**	**Coef. Mayorar (REBT)**	**Amperios**	**Factor de simultaneidad**	**Unidades**	**Pot. Total a considerar (kW)**
Compresor 1 SM150 WC	400	197,88	0,9	219,87	7	1,25	396,6993841	1	1	247,35
Compresor 2 SM150 WC	400	197,88	0,9	219,87	7	1,25	396,6993841	1	1	247,35
Resistencias caldeo (compresores)	230	0,1	1	0,10	1	1	0,25102922	1	4	0,4
Secador de adsorción 1	230	0,5	1	0,50	1	1	1,255146099	1	1	0,5
Secador de adsorción 2	230	0,5	1	0,50	1	1	1,255146099	1	1	0,5
X8i	230	0,2	1	0,20	1	1,8	0,903705191	1	1	0,36
								Potencia total sistema (kW)		496,46

3.1.3 Red de agua de condensados

La red de aguas de condensados recogerá el agua procedente de los equipos. Dicho agua se dirigirá un colector común donde terminarán en una arqueta no registrable.

Se utilizará el sistema ACO drain para derivar estas aguas hasta la arqueta, puesto que no se debe de utilizar tubo cerrado debido a que los condensados del compresor van a diferentes presiones.

3.1.4 Instalación de agua de refrigeración

Fuera del alcance de IR. El cliente, deberá además cumplir con los parámetros que figuran en el manual de operación y mantenimiento de los compresores para asegurar el buen funcionamiento y la garantía de los equipos.

3.2 Auditoría Energética

3.2.1 Introduccion

La finalidad de toda auditoría energética es, con valores tomados in situ, evaluar y valorar posibles mejoras futuras derivadas de un envejecimiento de los equipos, nuevas demandas, etc…

A tal efecto, en este proyecto se llevará a cabo una auditoria energética simulando una mejora de la línea basada en datos tomados de otra instalación mal conceptuada con los mismos compresores y equipos que los ofertados para esta planta.

3.2.2 Procedimiento

Para evaluar el funcionamiento de estos equipos se tomarán medidas de presión a la salida del deposito de 6000l y con la ayuda de una pinza amperimétrica se tomarán medidas de la intensidad que circula por los equipos.

Con los datos obtenidos y con la ayuda del programa INTELLISURVEY 3.2, propiedad de Ingersoll Rand para su uso exclusivo en auditorias de este tipo se propondrá unA solución de mejora para la planta que nos atañe.

3.2.3 Estudio económico

Finalmente, con los datos recogidos en el estudio energético se llevará a cabo la tarea más difícil de todas las que nos encontramos. Hacer ver al cliente la necesidad y conveniencia de invertir una cantidad de dinero que redundará en su beneficio.

4.CÁLCULOS

ÍNDICE GENERAL CÁLCULOS

4.1.1 Criterios de cálculo de tuberías para aire comprimido

4.1.1.1 Ecuaciones generales empleadas

Mediante la fórmula general de Darcy-Weisbach podemos relacionar la pérdida de carga unitaria (ΔPL) de un fluido de densidad conocida (ρ) a traves de un conducto de material y diámetro (D) conocidos a una determinada velocidad (V).

$$\Delta PL = f\left(Re, \frac{\delta}{D}\right) \cdot \frac{1}{D} \cdot \frac{V^2}{2}$$

Siendo el coeficiente de fricción (λ) función del número de Reynolds (Re) y el cociente entre el coeficiente de rugosidad de la tubería (δ) y el diámetro de la conducción conocidos.

De entre las muchas formas de expresar la ecuación de Darcy-Weisbach, la anteriormente expuesta tiene la ventaja de permitir la determinación de a través del ábaco de Moody o de una extensa variedad de ecuaciones semiempíricas que permiten particularizar el cálculo para el caso práctico al que se aplique, como en este caso es el flujo de aire comprimido. En cualquier caso, la experiencia demuestra que el valor de está muy próximo en este caso a 0,02.

4.1.1.2 Determinación de la pérdida de carga unitaria

Para el cálculo aplicado a una conducción de aire comprimido, la ecuación de determinación de la pérdida de carga se expresará mediante una aproximación a la expresión de Darcy-Weisbach que conlleva un cálculo sistemático mucho más sencillo sin necesidad de emplear ábacos:

$$\Delta PL = \frac{60}{(P+1)\cdot D^5}\cdot Q^3$$

Donde expresando D en mm, Q en litros/min y P en bar, la pérdida de carga resulta en mbar/m. La pérdida total de carga que se produce en el tramo vendrá determinada por la siguiente ecuación:

$$\Delta P_t = \Delta PL \cdot (L + L_{eq})$$

Donde:

- ΔP_t = Pérdida de carga total en el tramo, en mbar.
- ΔPL = Pérdida de carga unitaria, en mbar /m
- L = Longitud del tramo, en metros
- L_{eq} = Longitud equivalente de los accesorios del tramo, en metros.

Para determinar la longitud equivalente en accesorios, utilizamos la relación L/D (longitud equivalente / diámetro interior). Para cada tipo de accesorio consideramos la siguientes relaciones L/D:

Accesorio	**L/D**
Codo a 90°	55
Codo a 45°	30
Curva a 180°	133
Curva a 90°	16
Curva a 45°	8
Te	74

4.1.1.3 DETERMINACION DEL DIÁMETRO

Puesto que en el caso de aplicar la ecuación de determinación de pérdida de carga unitaria anteriormente expuesta se debe conocer primero el diámetro, resulta más sencillo emplear la expresión siguiente, en el que dicha pérdida de carga se ha sustituido iterando la expresión del caudal (Velocidad x sección de la conducción).

$$D = 2 \cdot \sqrt{\frac{Q}{60} \cdot \frac{10^6}{V \cdot \pi} \cdot \frac{1}{P}}$$

D = Diámetro interior de la tubería en mm.

Q = Caudal de aire circulante por la tubería en m3/min

V = Velocidad máxima del aire en la tubería en m/sg.

P = Presión del aire en la tubería (bar)

Se determina el diámetro interior de un tramo de conducción, en el cual conocemos la presión, el caudal y fijando una velocidad límite para la circulación del aire.

Las velocidades límite consideradas en función del tramo de la red, son las siguientes:

- Tubería de distribución principal: 8 m/s
- Tubería de distribución a tomas: 6 m/s

4.1.1.4 DETERMINACION DE LA VELOCIDAD

Para obtener la velocidad real del aire por un tramo de tubería, se emplea el diámetro obtenido en el epígrafe anterior, el cual será superior o en el peor de los casos igual al valor calculado, de modo que conseguimos asegurar que la velocidad máxima se respete.

Estos valores sustituidos en la ecuación siguiente, nos aportará el valor real de la velocidad del aire circulante por la tubería:

$$V = \frac{Q}{60} \cdot \frac{10}{\left(\frac{1}{2} \cdot D^2\right) \cdot \pi} \cdot \frac{1}{P}$$

D = Diámetro interior de la tubería en mm.

Q = Caudal de aire circulante por la tubería en m3/min

V = Velocidad máxima del aire en la tubería en m/sg.

P = Presión del aire en la tubería (bar)

Se adjunta al presente documento hoja de cálculo de la red de distribución de aire comprimido según se ha planteado en planos del proyecto, en el que se determinan las magnitudes consideradas en los epígrafes anteriores de acuerdo a las ecuaciones expuestas:

Identificación	Long (m)	Long eq (m)	Vel (m/s)	Consumo (m3/min) máximo	Pres (barg)	Dmín (mm)	Diámetro mín acero DIN 2440	Diám int	V real	Pérdida de carga (bar)
TRAMO PRINCIPAL	40	35,85	8	19,435	7	85,818	4" (6" por posible expansión del circuito)	150	2,619	***0,00283***
TRAMO PRINCIPAL - TOMA J	20	9,3	8	6,2	7	48,471	4" (por posible expansión)	100	1,88	***0,000845***
TOMA J - TOMA K	40	24,1	8	3,1	7	34,274	4" (por posible expansión)	100	0,94	***0,000462***
TOMA K - PUNTO CONJUNTO	15	16,7	8	6,2	7	48,471	4" (por posible expansión)	100	1,88	***0,000914***
PUNTO CONJUNTO - ANILLO PINTURA	15	9,3	8	6,2	7	48,471	4" (por posible expansión)	100	1,88	***0,000701***
PUNTO ANILLO PINTURA - TOMA L1	11,2	4,65	8	6	7	47,683	2"	50	7,276	***0,013694***
PUNTO ANILLO PINTURA - TOMA L2	11,2	4,65	8	6	7	47,683	2"	50	7,276	***0,013694***
TOMA L1 - TOMA M1	7,4	3,7	8	4,2	7	39,894	2"	50	5,093	***0,004699***
TOMA L1 - TOMA M2	7,4	3,7	8	4,2	7	39,894	2"	50	5,093	***0,004699***
TOMA M1 - TOMA M2	22,8	7,4	8	3	7	33,717	2"	50	3,638	***0,006523***
TRAMO PRINCIPAL TOMA A1	10,1	11,1	8	12,47	7	68,741	3"	75	6,721	***0,010419***
TRAMO PRINCIPAL TOMA A2	10,1	11,1	8	12,47	7	68,741	3"	75	6,721	***0,010419***
TOMA A1- TOMA B1	8	5,55	8	10,67	7	63,587	3"	75	5,75	***0,004876***
TOMA A2- TOMA B2	8	5,55	8	10,67	7	63,587	3"	75	5,75	***0,004876***
TOMA B1- TOMA C1	8	5,55	8	9,97	7	61,466	3"	75	5,373	***0,004257***
TOMA B2- TOMA C2	8	5,55	8	9,97	7	61,466	3"	75	5,373	***0,004257***
TOMA C1- TOMA D1	8	5,55	8	8,87	7	57,976	3"	75	4,78	***0,003369***

TOMA C2-TOMA D2	8	5,55	8	8,87	7	57,976	3"	75	4,78	***0,003369***
TOMA D1-TOMA E1	8	5,55	8	7,77	7	54,262	3"	75	4,188	***0,002585***
TOMA D2-TOMA E2	8	5,55	8	7,77	7	54,262	3"	75	4,188	***0,002585***
TOMA E1-TOMA F1	8	6,975	8	7,18	7	52,161	3"	75	3,87	***0,00244***
TOMA E2-TOMA F2	8	6,975	8	7,18	7	52,161	3"	75	3,87	***0,00244***
TOMA F1-TOMA G1	8	6,975	8	6,48	7	49,553	3"	75	3,492	***0,001987***
TOMA F2-TOMA G2	8	6,975	8	6,48	7	49,553	3"	75	3,492	***0,001987***
TOMA G1-TOMA H1	8	5,5	8	5,64	7	46,23	3"	75	3,04	***0,001357***
TOMA G2-TOMA H2	8	5,5	8	5,64	7	46,23	3"	75	3,04	***0,001357***
TOMA H1-TOMA I1	8	5,5	8	4,8	7	42,649	3"	75	2,587	***0,000983***
TOMA H2-TOMA I2	8	5,5	8	4,8	7	42,649	3"	75	2,587	***0,000983***
TOMA I1-PUNTO COJUNTO	20,9	5,55	8	3	7	33,717	3"	75	1,617	***0,000752***
TOMA I2-PUNTO COJUNTO	20,9	5,55	8	3	7	33,717	3"	75	1,617	***0,000752***
TOMA RÁPIDA A1	4,4	6,45	3	1,8	7	42,649	2"	50	2,183	***0,000844***
TOMA RÁPIDA A2	4,4	6,45	3	1,8	7	42,649	2"	50	2,183	***0,000844***
TOMA RÁPIDA B1	4,4	3,225	6	0,7	7	18,806	1"	25	3,395	***0,002869***
TOMA RÁPIDA B2	4,4	3,225	6	0,7	7	18,806	1"	25	3,395	***0,002869***
TOMA RÁPIDA C1	4,4	3,225	6	1,1	7	23,575	1"	25	5,335	***0,007086***
TOMA RÁPIDA C2	4,4	3,225	6	1,1	7	23,575	1"	25	5,335	***0,007086***
TOMA RÁPIDA D1	4,4	3,225	6	1,1	7	23,575	1"	25	5,335	***0,007086***
TOMA RÁPIDA D2	4,4	3,225	6	1,1	7	23,575	1"	25	5,335	***0,007086***
TOMA RÁPIDA E1	4,4	3,225	6	0,59	7	17,266	1"	25	2,862	***0,002038***
TOMA RÁPIDA E2	4,4	3,225	6	0,59	7	17,266	1"	25	2,862	***0,002038***
TOMA RÁPIDA F1	4,4	3,225	6	0,7	7	18,806	1"	25	3,395	***0,002869***
TOMA RÁPIDA F2	4,4	3,225	6	0,7	7	18,806	1"	25	3,395	***0,002869***

TOMA RÁPIDA G1	4,4	3,225	6	0,84	7	20,601	1"	25	4,074	***0,004132***
TOMA RÁPIDA G2	4,4	3,225	6	0,84	7	20,601	1"	25	4,074	***0,004132***
TOMA RÁPIDA H1	4,4	3,225	6	0,84	7	20,601	1"	25	4,074	***0,004132***
TOMA RÁPIDA H2	4,4	3,225	6	0,84	7	20,601	1"	25	4,074	***0,004132***
TOMA RÁPIDA I1	4,4	6,45	3	1,8	7	42,649	2"	50	2,183	***0,000844***
TOMA RÁPIDA I2	4,4	6,45	3	1,8	7	42,649	2"	50	2,183	***0,000844***
TOMA L1 (FIJA)	4,4	6,45	3	1,5	7	38,933	2"	50	1,819	***0,000586***
TOMA L2 (FIJA)	4,4	6,45	3	1,5	7	38,933	2"	50	1,819	***0,000586***
TOMA M1 (FIJA)	4,4	6,45	3	1,5	7	38,933	2"	50	1,819	***0,000586***
TOMA M2 (FIJA)	4,4	6,45	3	1,5	7	38,933	2"	50	1,819	***0,000586***
TOMA J (FIJA)	6,66	9,675	3	3,1	7	55,969	3"	75	1,671	***0,000496***
TOMA K (FIJA)	6,66	9,675	3	3,1	7	55,969	3"	75	1,671	***0,000496***

PÉRDIDAS TOTALES A PLENO CONSUMO	***0,182249595***

4.2Auditoría energética

4.2.1. Datos y características de la medición

Ficha resumen alcance suministro sistema

Cliente:	Renault (Valladolid)- Sala de retoque
Unidades Analizadas	2 Compresores rotativos línea 7 bares
Fluido:	Aire
Fecha de toma de datos	Del 7/08/2010 al 13/08/2010
Tipo de análisis	Toma de datos de consumos eléctricos, presiones de línea.
Motivo de la auditoría	Estimación ahorros energéticos.

4.2.2 Objetivos

- Caracterizar la instalación determinando los parámetros de funcionamiento presión, y potencia de los compresores.
- Analizar la Energía consumida por los compresores y funcionamiento a lo largo del día.
- Estimación de posibilidades de mejora y ahorros de energía en función de los datos recogidos.

4.2.3 Toma de datos

Durante cinco días se tomaran parámetros de funcionamiento habituales de los 2 equipos de aire comprimido para la red de generación de 7 bares.

Tiempo de toma de datos:

Periodo A: De 14:11:54 del 7/08/2010 a 14:11:35 del 13/08/2010.

En el periodo A, los compresores estarán trabajando de manera habitual, tal y como lo hacen el resto del año.

Para poder caracterizar la línea se utilizan diferentes herramientas:

Intellisurvey

Con el moderno dispositivo de IR, conocido como Intellysurvey, se toman medidas, a través de una pinza amperimétrica en cada uno de los equipos, de la potencia y de la presión en cada segundo del intervalo de tiempo en que se lleva a cabo la medición.

A través del estudio de los valores obtenidos con esta herramienta, propiedad exclusiva de IR, podremos hacer una valoración de la conveniencia o no de implantar unas nuevas máquinas que nos redunden en un significante ahorro energético y por ende, económico.

Ingersoll Rand, como creadora del Intellysurvey orienta estos resultados a la implantación de su máquina mas eficiente. El compresor NIRVANA, de velocidad variable, que permite infinitos arranques y paros sin que por ello se dañe su innovador motor hibrido de imanes permanentes, ahorrando así los costes que supone tener trabajando en vacío a un compresor cuyo régimen de trabajo es TODO-NADA como ocurre en el caso de los Compresores Sierra de la instalación.

4.2.4. Descripción de la instalación

La instalación consta de dos compresores, dos secadores de adsorción, filtros de línea y un calderin de 6000l que se encargan de proporcionar la presión necesaria así como mantener el aire en perfectas condiciones para su posterior uso. El tipo de compresor y sus características se pueden observar a continuación:

Compresor SIERRA SM150 WC Oil-free

- Capacidad teórica de caudal: 24,6 m3/min
- Potencia nominal a plena carga: 159 Kw
- Alimentación eléctrica: 400 V
- Presión máxima de funcionamiento: 8.5 barg
- Potencia consumida en vacío: 60 Kw

Presentado a:

RENAULT

Calle Fabrica Renault nº1, Valladolid, Valladolid, 47003

JESUS RODRIGUEZ RODRIGUEZ
INGERSOLL RAND
TIERRA DE BARROS 2
COSLADA, MADRID , 28020
Teléfono: 647452720
Fax: (+34) 91 6277404
Fecha: septiembre 28, 2011

Tabla de contenidos:

Ingersoll Rand

Propósito y valor del IntelliSurvey:

Cada año las empresas gastan una cantidad significativa de dinero en comprimir aire para realizar o apoyar su proceso de producción

- Funcionamiento del sistema ineficiente e ineficaz
- Mal uso de los componentes del sistema de aire
- Demanda artificial y fugas del sistema

"Además, los mismos estudios muestran una poca atención entre los propietarios, departamento de procesos y de operaciones de los ahorros significativos disponibles por medio de la optimización del sistema de aire. La optimización de un sistema de aire comprimido comienza con una investigación del funcionamiento del sistema durante un ciclo de operación completo (típicamente 7 días). Una vez que se registran todos los datos, se analizan los prámetros de funcionamiento y perfiles utilizando los principios de la ciencia del aire comprimido para definir claramente las características del sistema actual. Es sólo tras este análisis cuando se pueden hacer planes de recomendaciones o soluciones. "

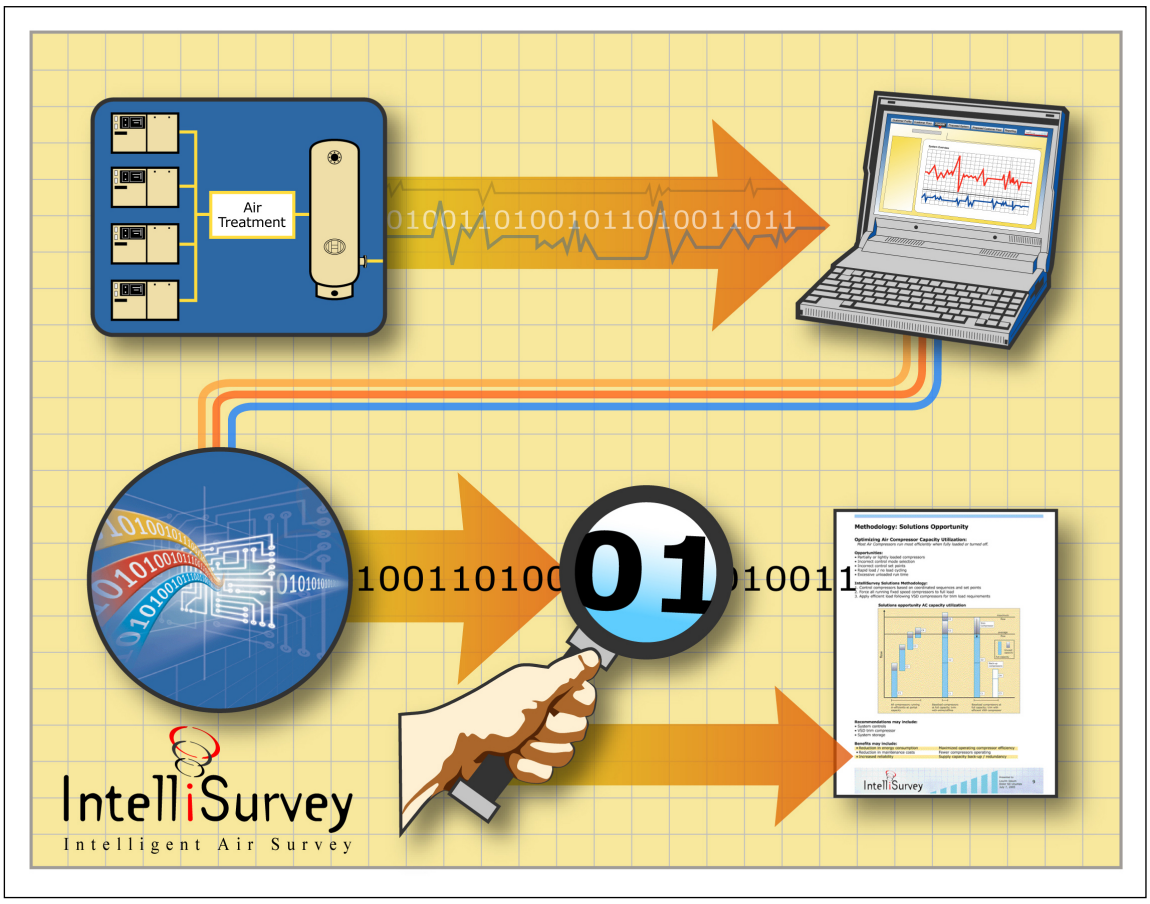
Nuestro objetivo es ofrecer soluciones reales basadas en en el análisis de datos reales

IntelliSurvey

"Soluciones sin datos, conocimiento del sistema ni análisis son simplemente suposiciones "

Resumen ejecutivo:		
Oportunidad total de ahorros :	**€ 24,499**	
Número de compresores considerados	2	
Numero de horas de recogida de datos	3,686	horas
Caudal total de los compresores instalados	50.04	m3/min
Caudal medio utilizado	23.79	m3/min
Máximo	40.04	m3/min
Mínimo	6.67	m3/min
Presión media	6.92	barg
Máxima	7.08	barg
Mínima	1.65	barg
Nivel de calidad de aire	6.-.1	
Funcionamiento anual del sistema	6,244	horas
Coste anual estimado de la energía en el sistema existente	1,149,188	kW-h
Precio medio de la energía	0.1140	€/kW-h
Costes anual actual de energía - Total (estimados)	131,007	€
Coste anual actual de energía - Improductiva (estimado)	24,499	ú
Nuevo coste anual de la energía (estimado)	106,508	€

Metodología:

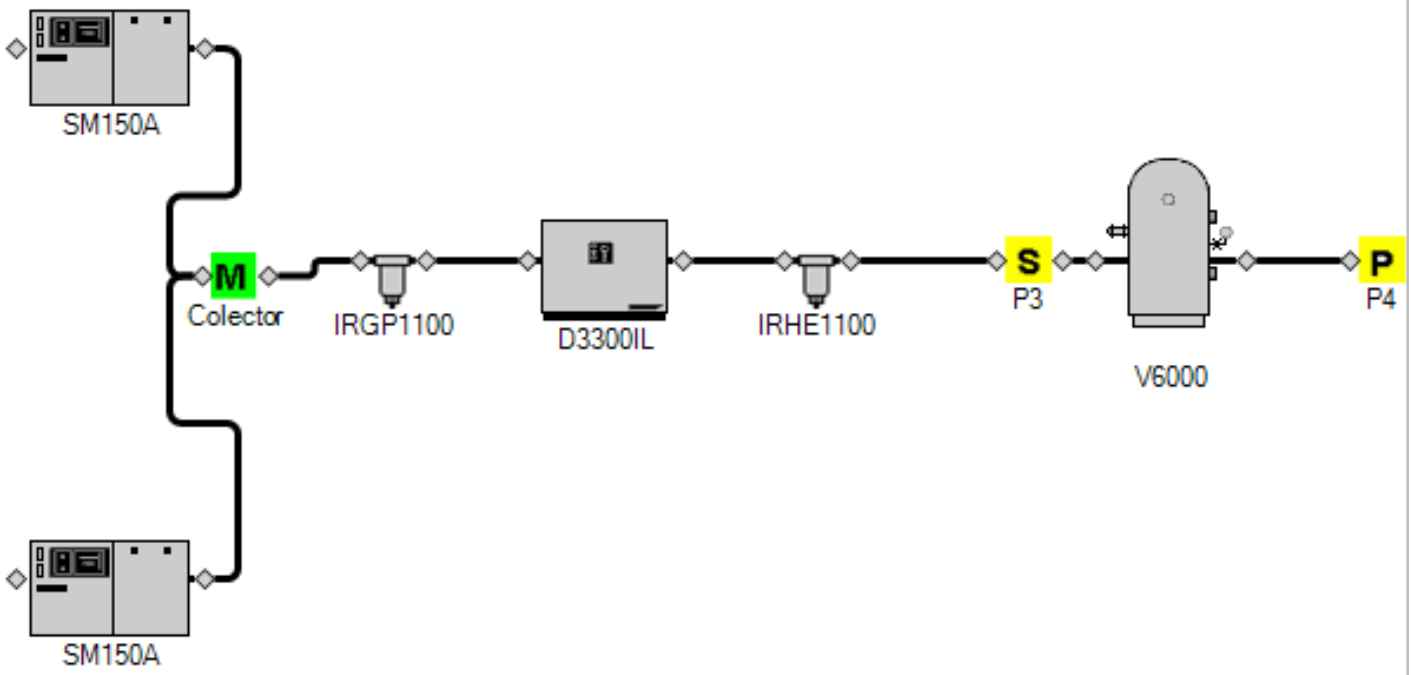


"Equipo multicanal instalado en los compresores para registrar datos críticos del sistema y así definir las características del sistema. Medimos la reacción de los compresores individualmente y la presión del sistema en relación a los procesos de demanda dinámica, lo que hace que sea imperativo tener la máxima resolución delos datos del sistema. El IntelliSurvey recoge datos cada segundo en todos los canales lo que implica más de 3,000,000 valores durante un ciclo de producción típico de 7 días."

"Una vez que se ha establecido la característica de funcionamiento del sistema, se realiza un análisis, utilizando los principios de la ciencia del aire comprimido, con el fin de identificar las oportunidades para reducir el consumo de energía y aumentar la fiabilidad del sistema. Se consideran numerosos factores, aunque las principales áreas son: utilización ineficiente del caudal del compresor, funcionamiento excesivo de los compresores en vacío, presión del sistema elevada, depósito de aire insuficiente y el mal uso de los componentes del sistema de aire."

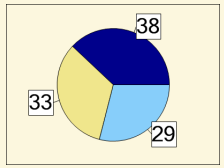
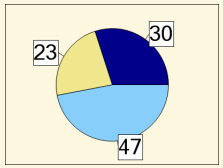
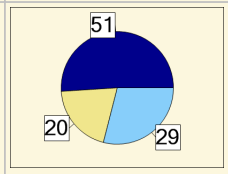
"Hay ocasiones donde se garantiza una investigación mayor, ya sea un análisis más detallado de los equipos del lado de suministro o una evaluación de la eficiencia y efectividad del aire comprimido en los puntos de uso (Auditoría del Sistema Total). Estás investigaciones pueden descubrir oportunidades de ahorros del doble de las apuntadas en un análisis básico. "

Esquema del lado de suministro existente



Esquema del lado de suministro existente		
Caudal disponible:	50.04	m3/min
Depósito seco	6000	Litros
$P2_1$	6.99	barg
$P2_2$	6.86	barg
P3	6.92	barg
Calidad del aire ISO:	2.2.1	
Temperatura ambiente:	20	ºC
Altitud:	690	m

Visión general del sistema existente

	Compresor 1	Compresor 2	Energía del sistema
Porcentaje de tiempo Cargado En vacío Apagado			

Resumen de caudal		Resumen de energía		Resumen de presión	
Disponible	50.04 m3/min	Energía media del sistema	184 kW	P3 máxima	7.08 barg
Máximo	40.04 m3/min	Energía en descarga	17.9 kW	P3 mínima	1.65 barg
Mínimo	6.67 m3/min	Eficiencia en carga	66 % del caudal total	P3 media	6.92 barg
Media	23.79 m3/min		87 % de la potencia total	P4 requerida	7 barg

Metodología: Oportunidad de caudal en la solución

Optimizando el uso de caudal de aire comprimido:

La mayoría de los compresores de aire funcionan de la forma más eficiente cuando están a plena carga o apagados.

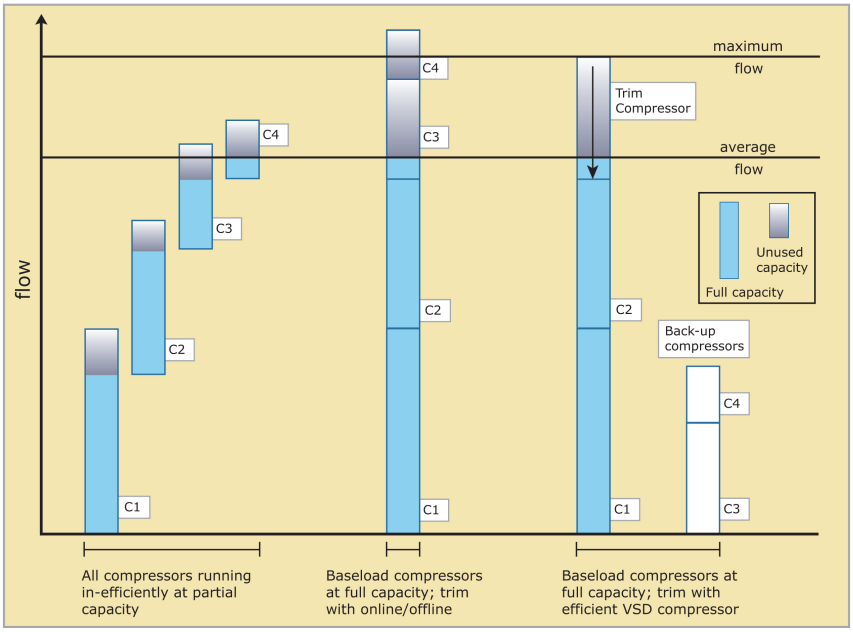
Oportunidades:

- Compresor con carga parcial o ligera
- Selección de modo de control incorrecta
- Puntos de ajustes de control incorrectos
- Ciclos rápidos de carga/vacío
- Tiempo excesivo de funcionamiento en vacío

Metodología de solución del IntelliSurvey:

1. Control del compresor basado en secuencias y puntos de ajustes coordinados
2. Fuerza a todos los compresores de velocidad fija funcionando a ponerse a plena carga
3. Para los requisitos de cargas parciales utiliza compresores VSD con una alta eficiencia

Utilización de la capacidad de la CA de la oportunidad de las soluciones



Las recomendaciones pueden incluir:

- Controles del sistema
- Compresor de apoyo VSD
- Depósito del sistema

Los beneficios pueden incluir:

▪ Reducción en el consumo de energía	Maximiza la eficiencia de funcionamiento de los compresores
▪ Reducción en los costes de mantenimiento	Menos compresores funcionando
▪ Aumento de fiabilidad	Reserva de suministro de caudal / redundancia

Resumen de ahorros propuestos

Ahorros

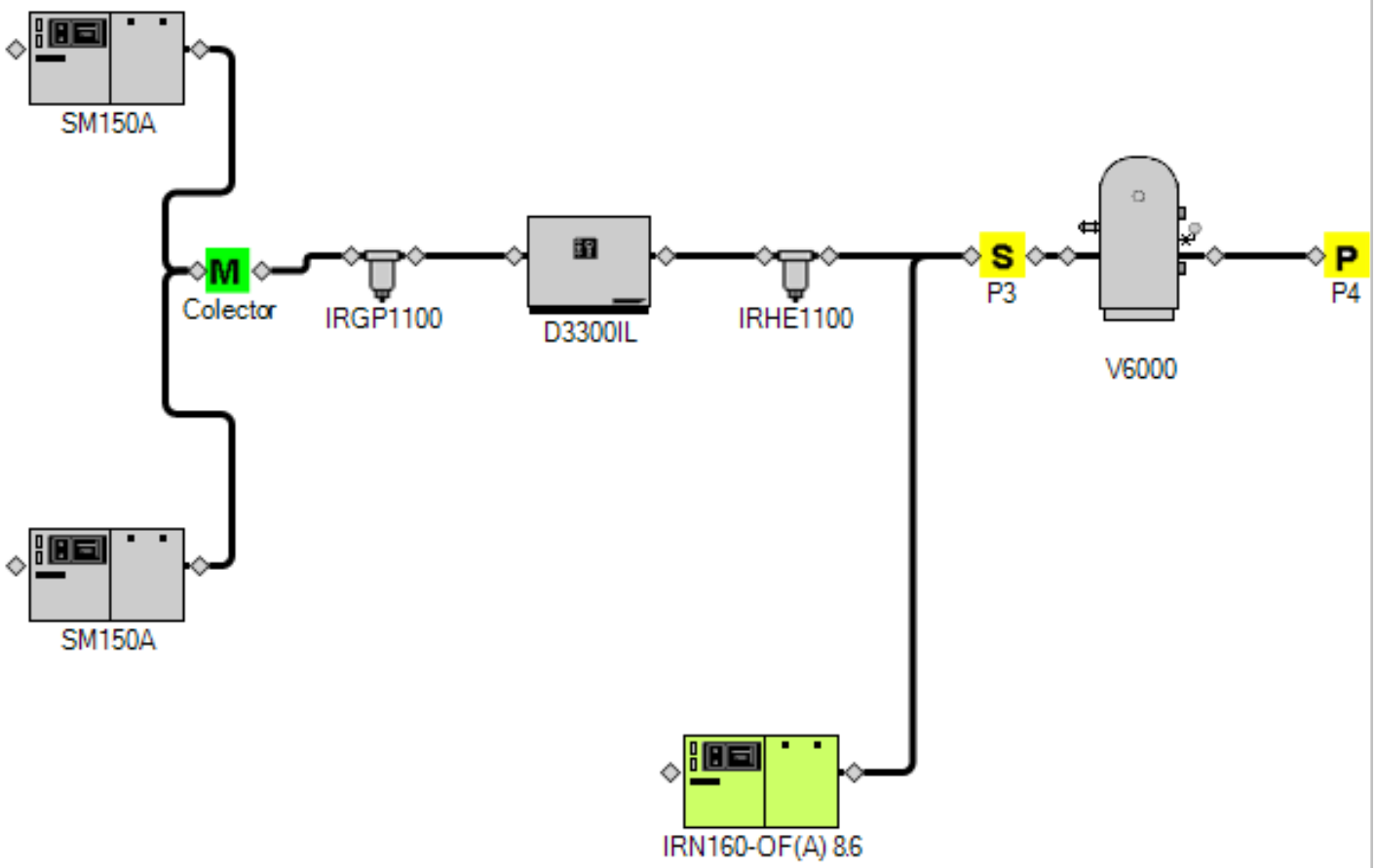
Equipos	Tamaño	Fuente de ahorros	Ahorros de energía estimados	Ahorros anuales estimados	Coste estimado	Costes estimados de instalación
Control de velocidad variable	IRN160-OF(A) 8.6	Reduce las cargas ineficientes	24.5 kW	€ 24499		
TOTAL				€ 24499		
Plazo de amortización						

"Examinando el punto de uso, o P5, aparecerán acciones directas hacia la causa raíz del problema y retirará los síntomas de un malos usos. El proceso de Solutionizingâ„¢ va más allá de P4 hasta P5 llegando al lado de suministro. Para determinar los ahorros asociados con esto se necesita una auditoría total del sistema."

Implementación del sistema propuesto

Recomendaciones sobre eficiencia:		
		Beneficio
Control de velocidad variable		24.5 kW Reducción

Esquema del lado de suministro propuesto



Esquema del lado de suministro propuesto		
$P2_1$	7	barg
$P2_2$	7	barg
P4	7	barg
Calidad del aire ISO:	6.-.1	
Temperatura ambiente:	20	ºC
Altitud:	690	m

Implementación de los productos

Optimizando el uso del compresor

Ingersoll-Rand Nirvana

- Control de caudal por velocidad variable
- Funcionamiento con ilimitados arranques/paradas
- Limita la corriente de arranque a menos del 100%

Los beneficios incluyen:

▪ Reducción en el consumo de energía	Las cargas del ajuste de las manijas en la eficacia de la carga completa permiten que los compresores fijos de la velocidad funcionen cargado completamente o apagado reducen al mínimo energía de unloaded/unproductive
▪ Reducción de los costes de mantenimiento	Menos compresores funcionando
▪ Aumento de la fiabilidad	Reserva de suministro de caudal / redundancia

Términos y condiciones

"El propósito de este Informe no es identificar errores, omisiones, defectos, violaciones de códigos o de instrucciuones de fabricante o ninguna condición real o potencial de peligro, e IR no debe ser acusada de fallo en descubrir dichas condiciones o de incluirlas en el Informe. Este Informe no debería constituir un asesoramiento profesional de ingeniería en ninguno de los siguientes campos: eléctrico, mecánico, estructural, cimentación o calefacción y ventilación. Los datos de caudal es caudal libre entregado basado en los datos publicados por los fabricantes. "

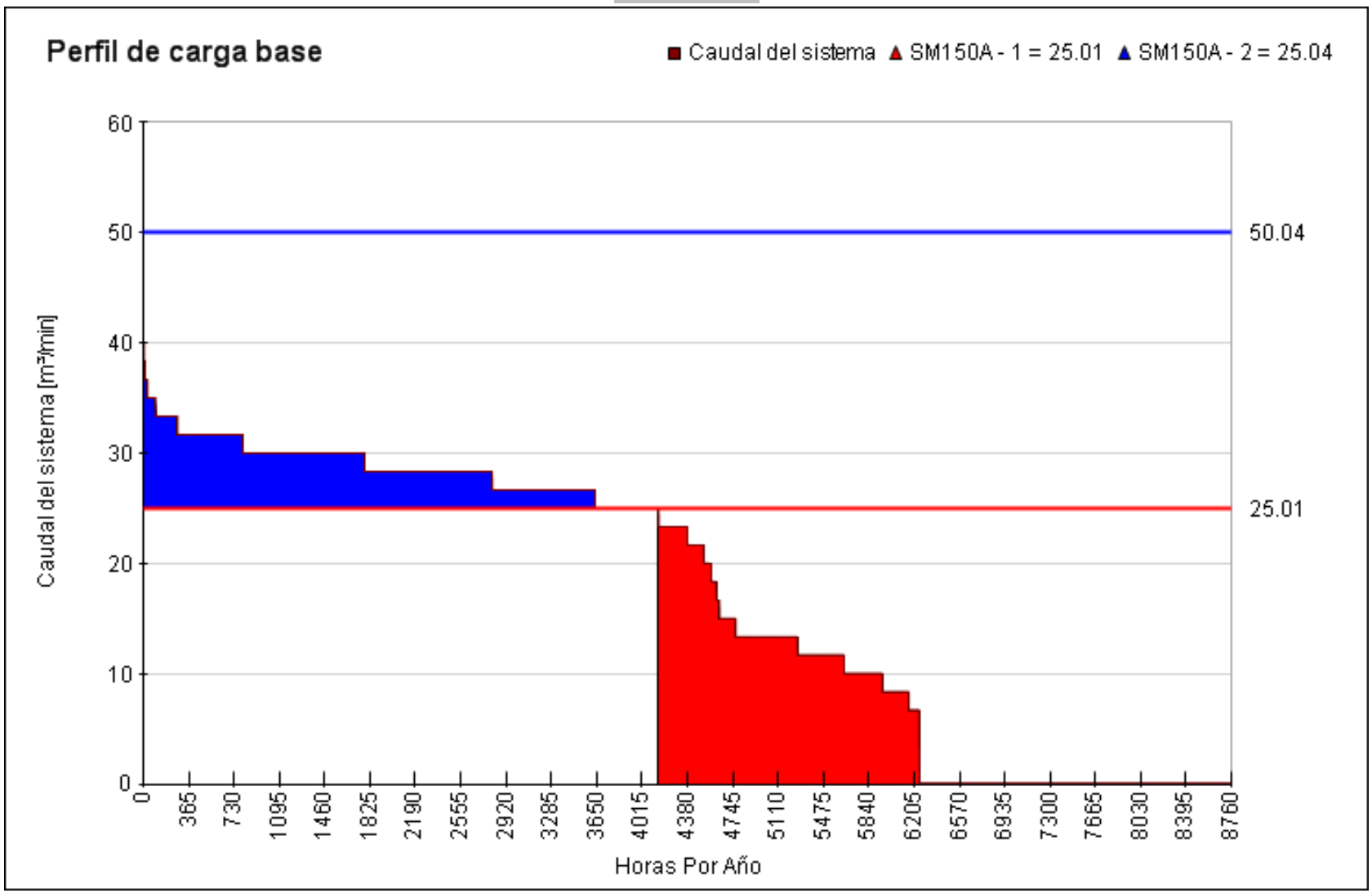
"EL VENDEDOR NO HACE NINGUNA OTRA GARANTÍA O REPRESENTACIÓN DE CUALQUIER TIPO TANTO EXPLÍCITA COMO IMPLÍCITA, EXCEPTO AQUELLAS DEL TÍTULO, Y TODAS LAS GARANTÍA IMPLICADAS EN EL COMERCIO PARA UN PROPÓSITO PARTICULAR SON POR LA PRESENTE OMITIDAS."

LIMITES DE RESPONSABILIDAD:

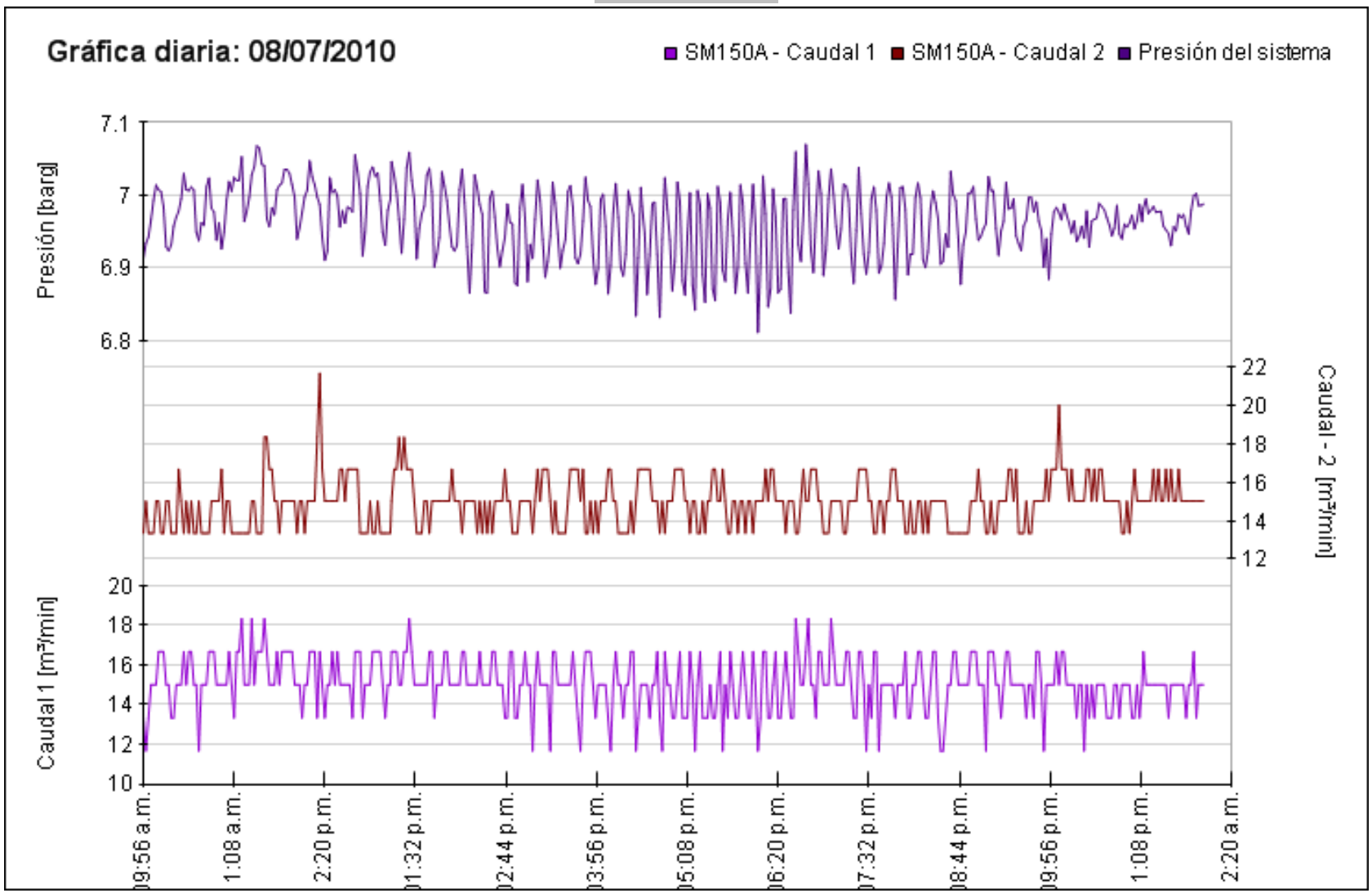
LAS SOLUCIONES DEL COMPRADOR EXPUESTAS AQUÍ SON EXCLUSIVAS Y LA RESPONSABILIDAD TOTAL DEL VENDEDOR CON RESPECTO A ESTE CONTRATO NO EXCEDERÁ EL PRECIO DEL CONTRATO.

"NINGUNA PARTE NI LOS SUMINISTRADORES SERÁN EN NINGÚN CASO RESPONSABLES FRENTE A OTRA, NINGÚN SUCESOR EN INTERÉS NI NINGÚN BENEFICIARIO O APODERADO DE ESTE CONTRATO PARA CUALQUIER DAÑO CONSECUENTE, CASUALES, INDIRECTOS, ESPECIALES NI PUNITIVOS QUE SURJAN FUERA DE ESTE CONTRATO NI NINGUNA INFRACCIÓN DEL MISMO, DEFECTO, FALLO, O FUNCIONAMIENTO DEFECTUOSO DEL EQUIPO A CONTINUACIÓN MENCIONADO, TANTO SI LA PÉRDIDA O DAÑO SE BASA EN UN CONTRATO, GARANTÍA, NEGLIGENCIA, INDEMNIDAD, OBLIGACIÓN ESTRICTA O DE OTRO MODO, COMO SI NO."

Perfil base


Perfil de carga base
Caudal del sistema
SM150A - 1 = 25.01
SM150A - 2 = 25.04
Caudal del sistema [m³/min]
60
50
40
30
20
10
0
50.04
25.01
0
365
730
1095
1460
1825
2190
2555
2920
3285
3650
4015
4380
4745
5110
5475
5840
6205
6570
6935
7300
7665
8030
8395
8760
Horas Por Año

Gráfica diaria



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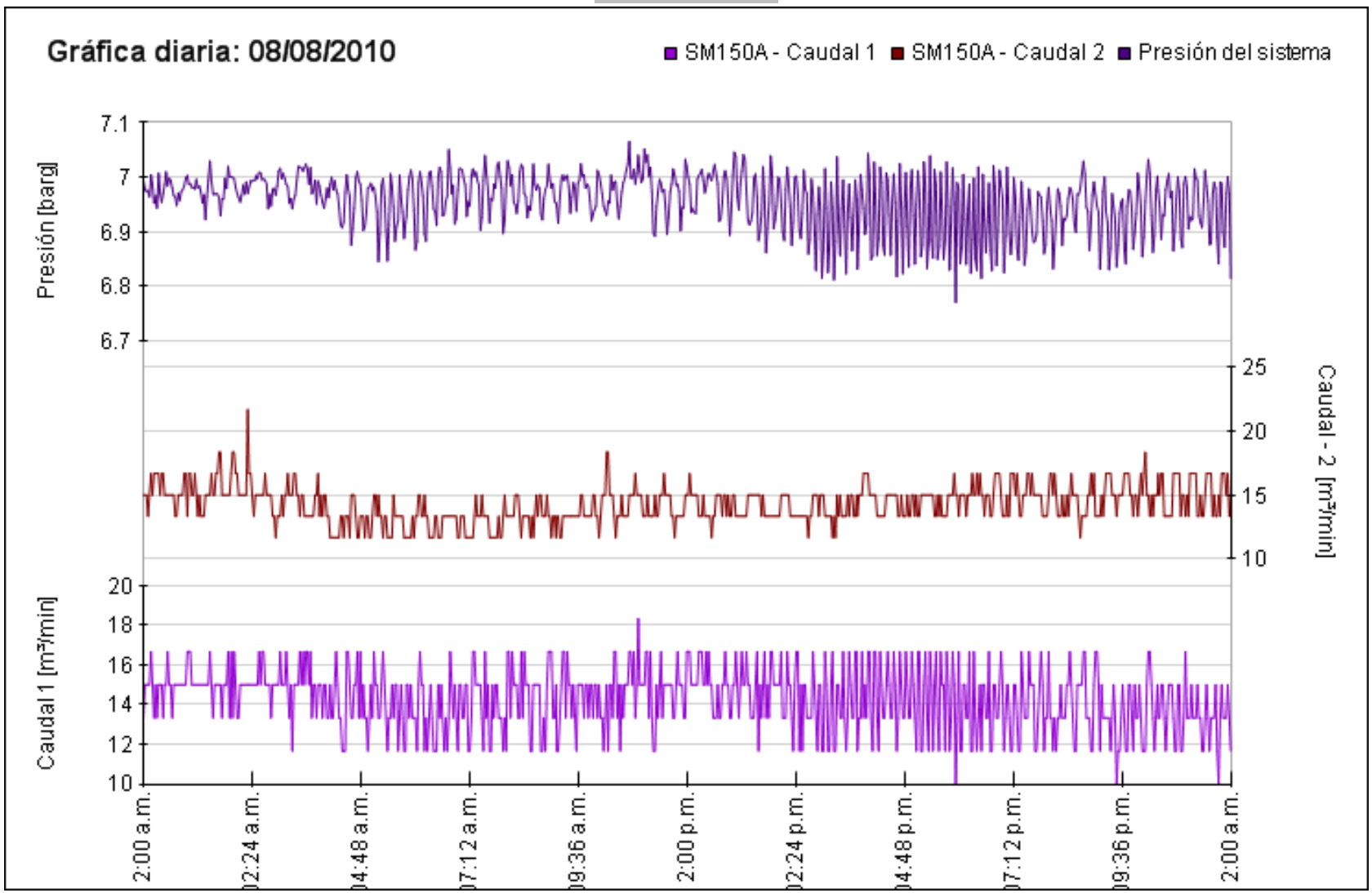
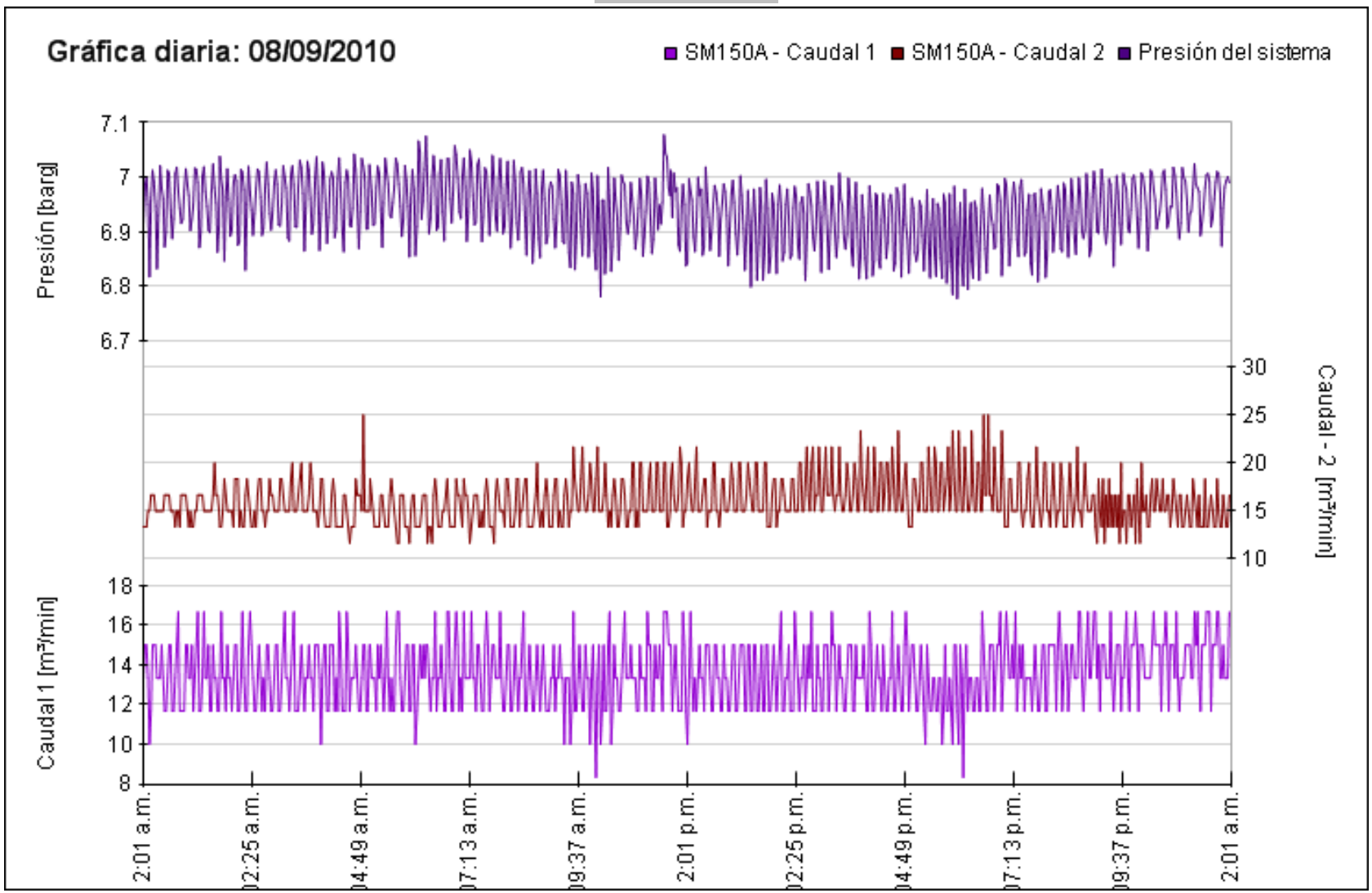


Gráfica diaria



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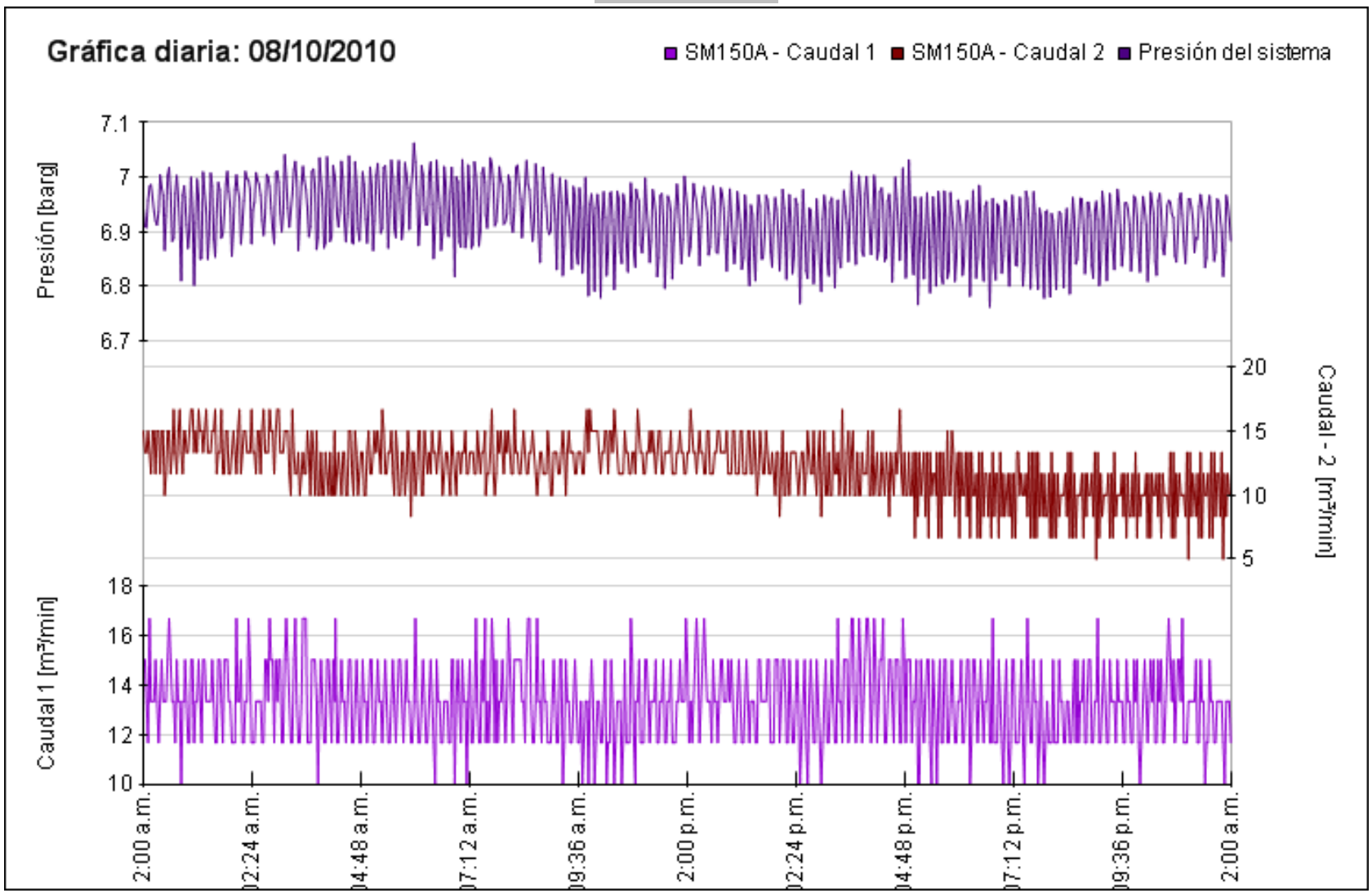

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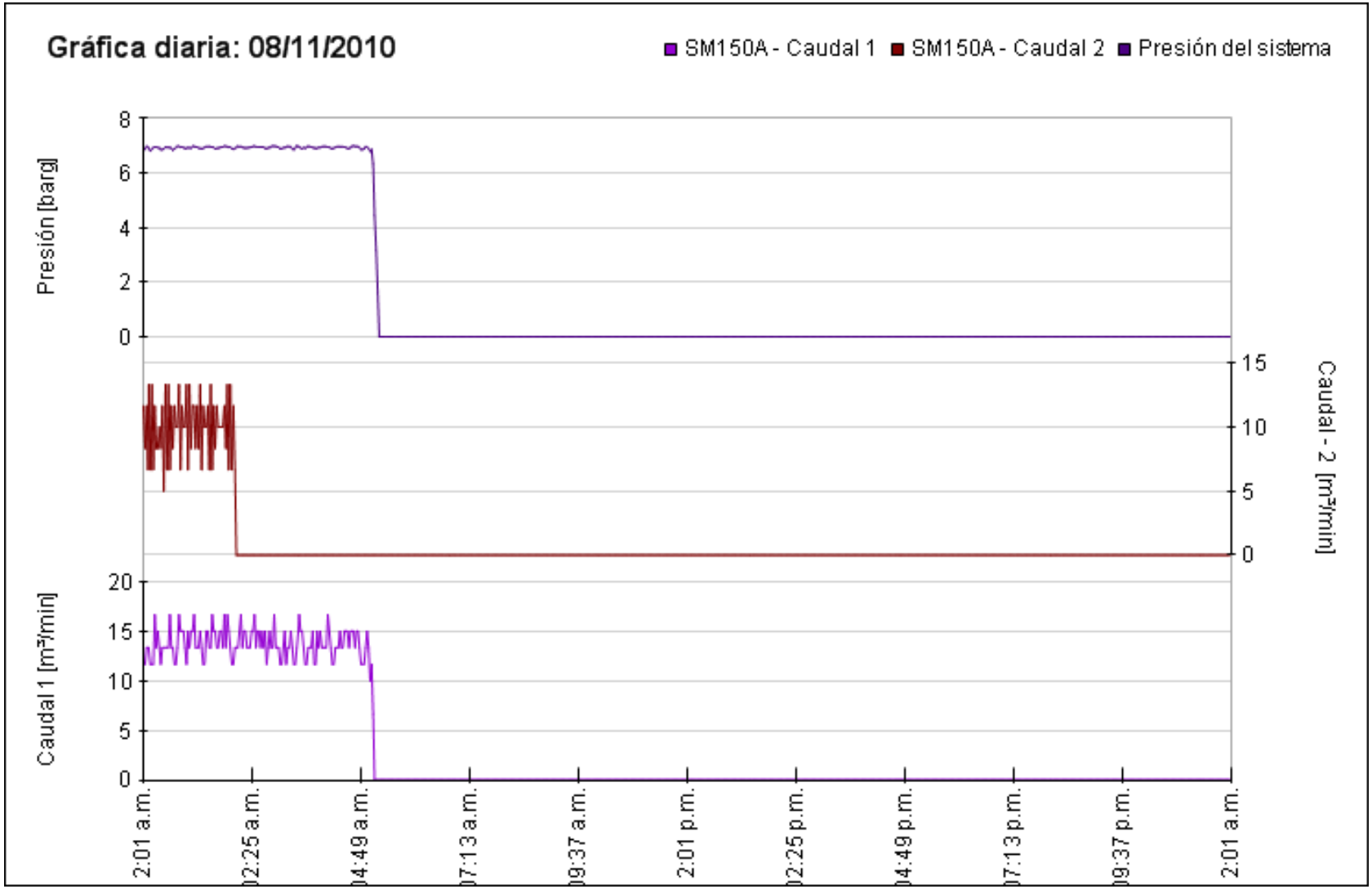

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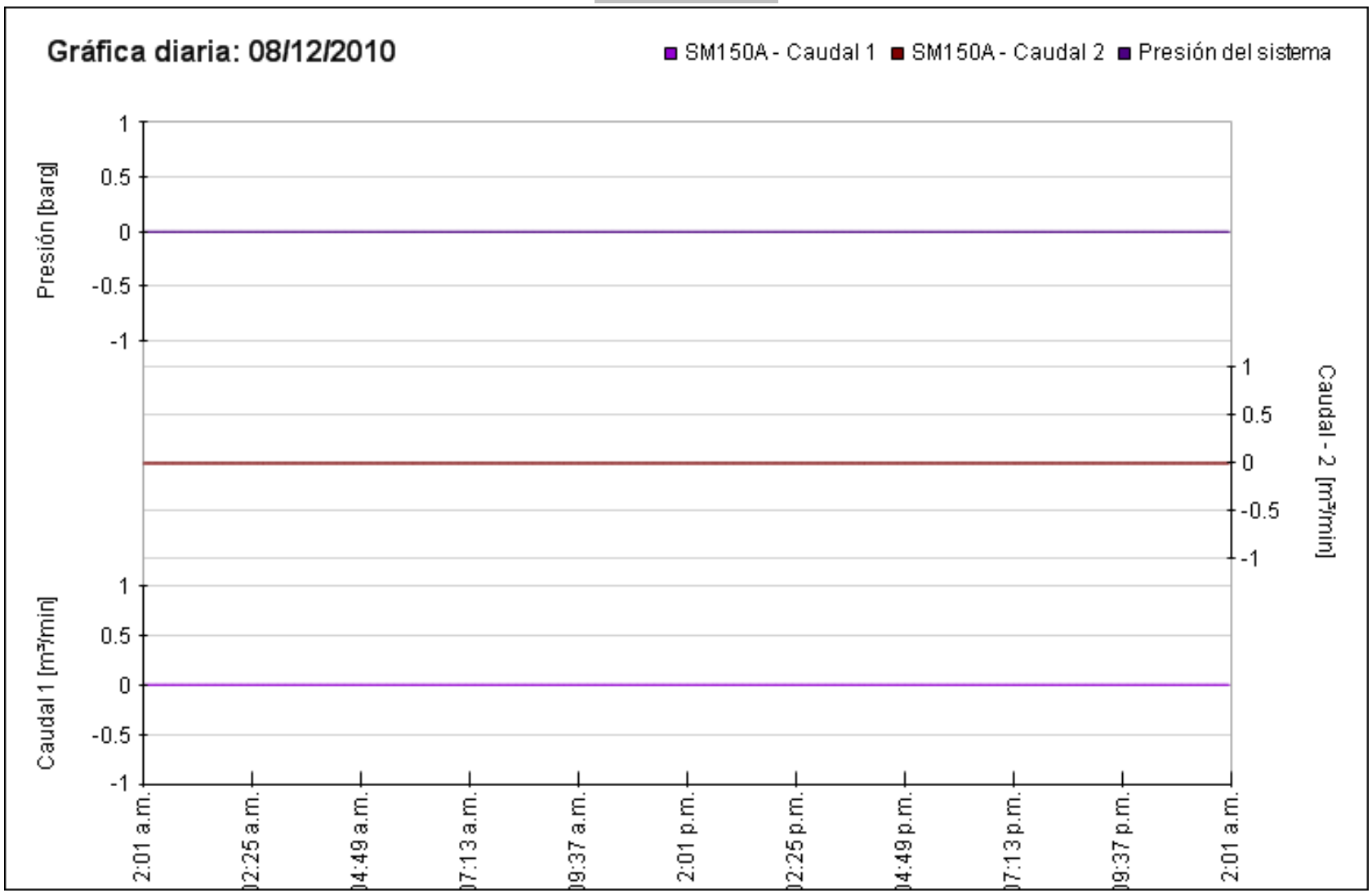

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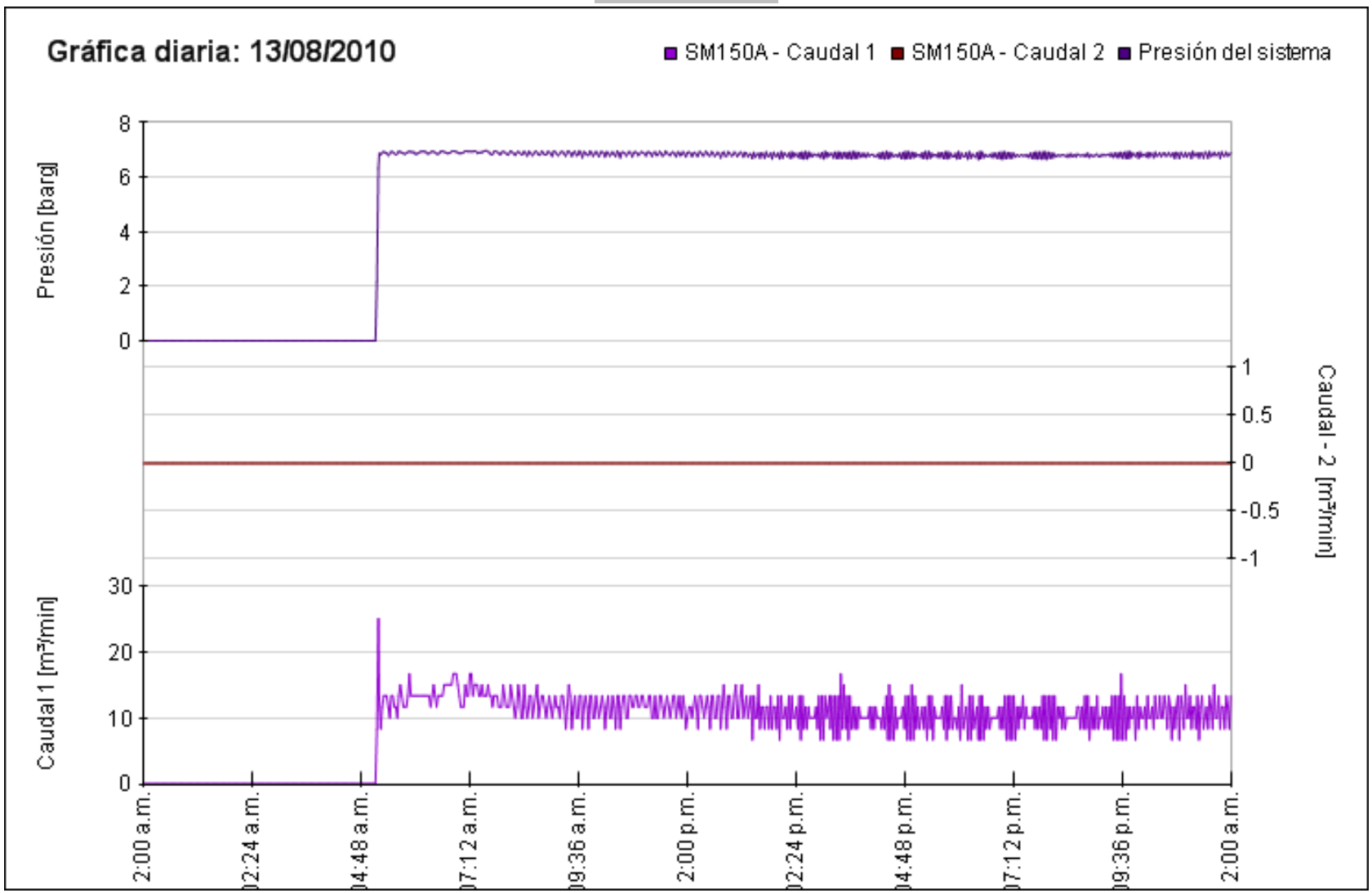

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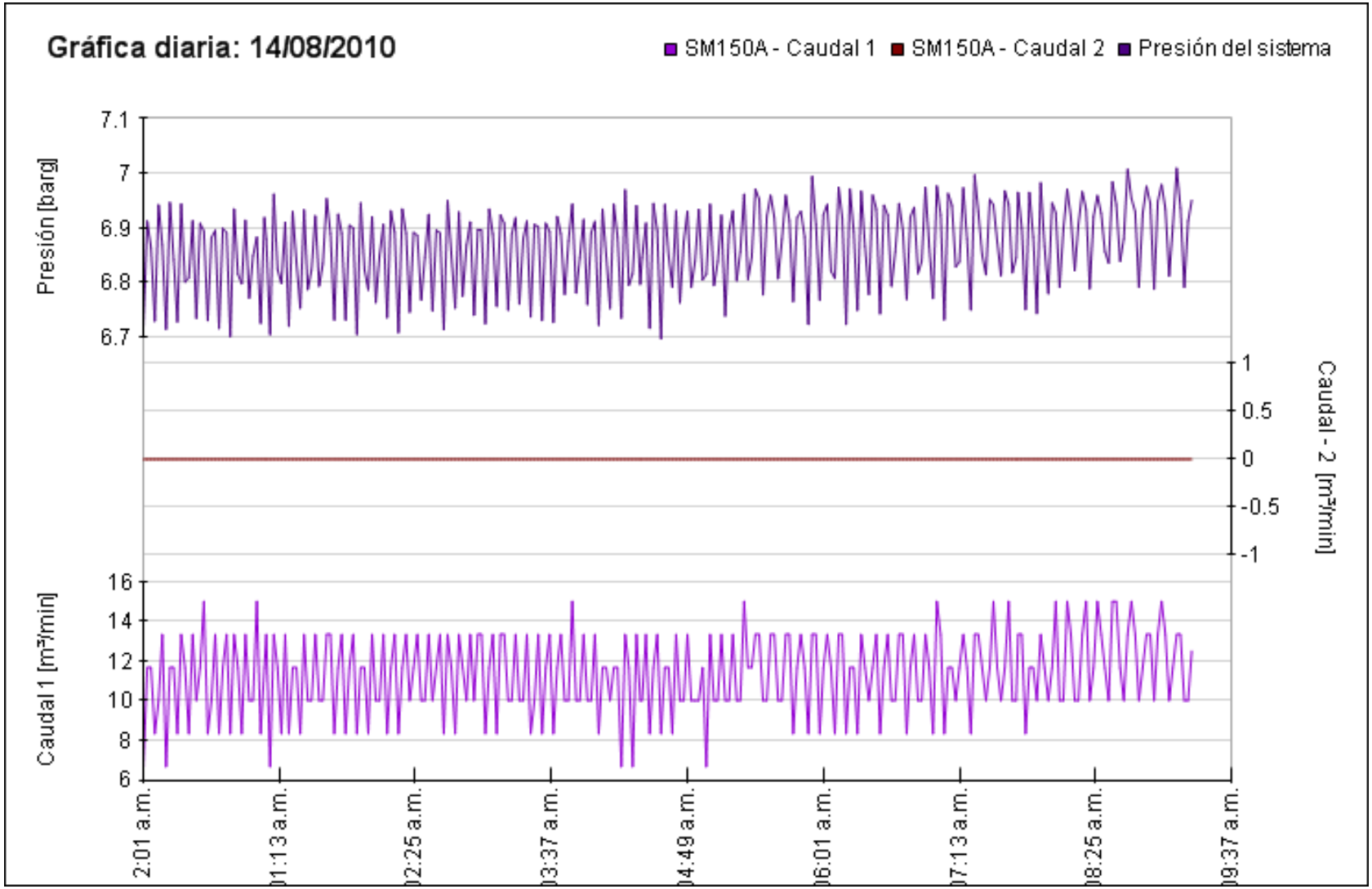
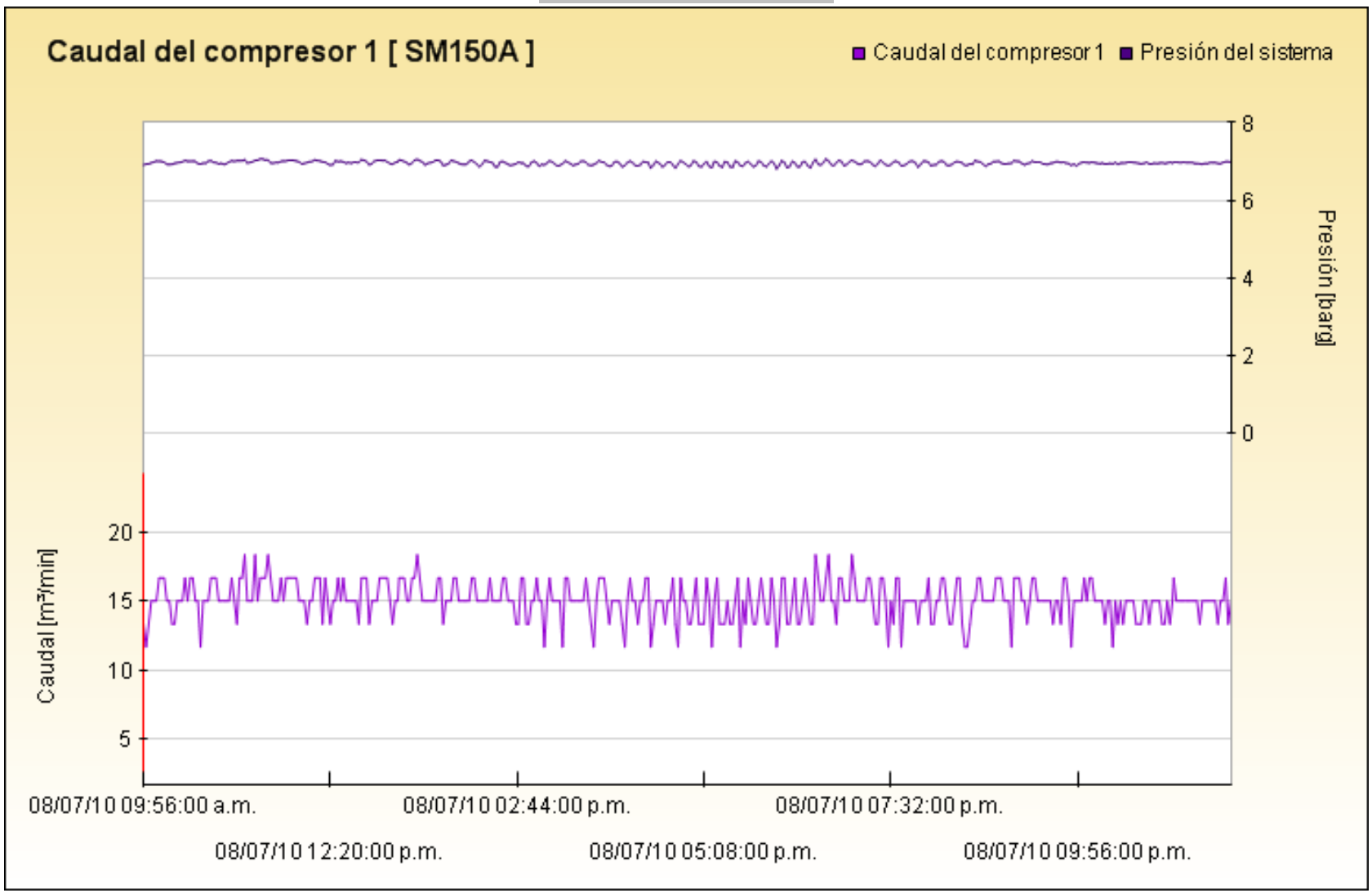
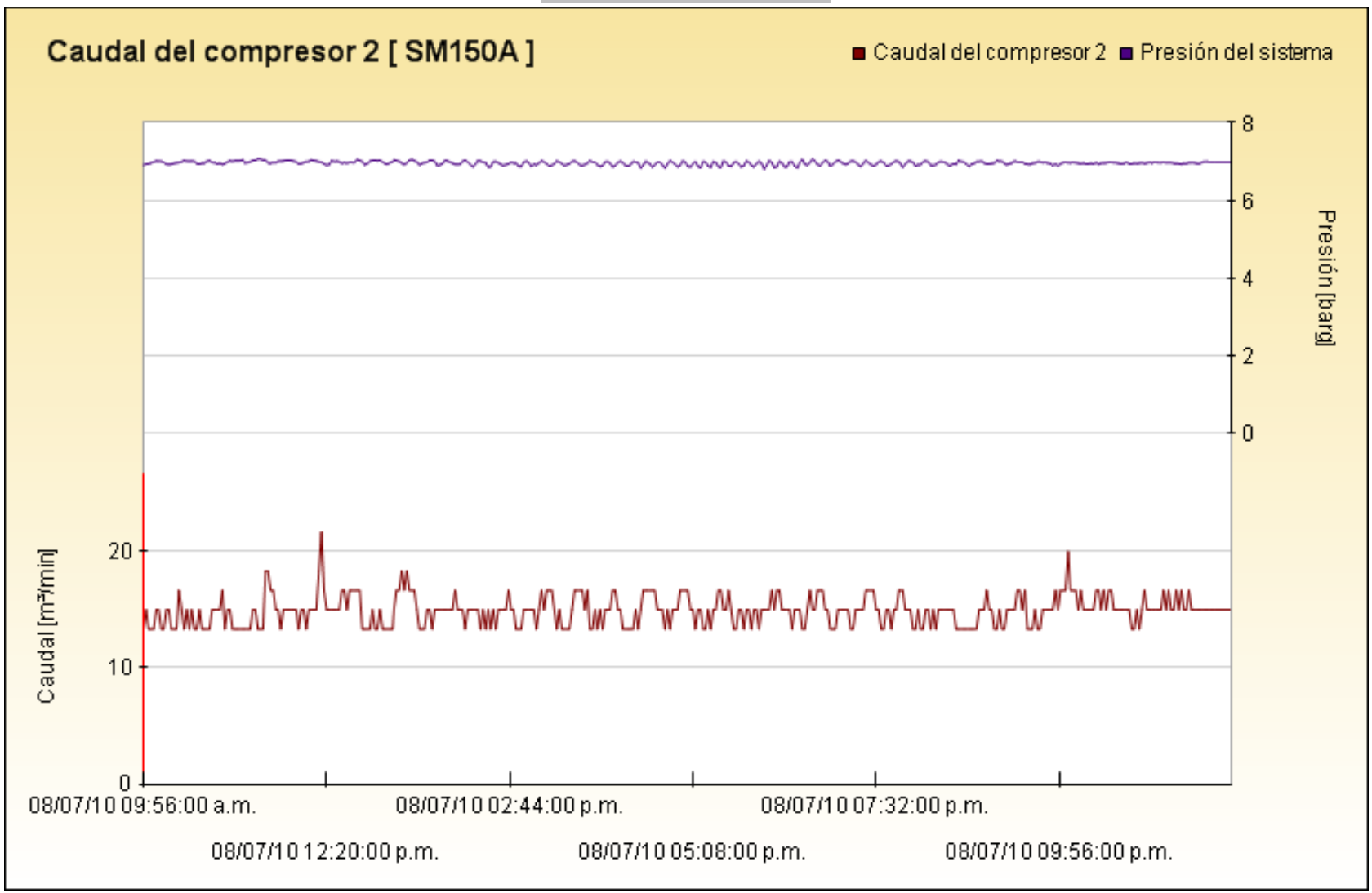


CAUDAL Compresor 1



CAUDAL compresor 2



5. CONCLUSIONES

Gracias al desarrollo de este proyecto –INSTALACION DE AIRE COMPRIMIDO- obtenemos diversas conclusiones que nos llevarán a comprender la enorme rentabilidad de esta forma de energía, con un correcto diseño, en la instalación del cliente que nos atañe.

La primera conclusión que obtenemos, es la versatilidad, uso y adaptabilidad del aire comprimido para multitud de aplicaciones como en este caso abastecer una gran línea de útiles de servicio que el cliente demanda.

Partiendo de las especificaciones iniciales del cliente en la que nos facilita un plano de la sala de la que dispone, las tomas de aire requeridas, la simultaneidad de los útiles consumidores, la capacidad de aire que necesita y el régimen de trabajo de los equipos que quiere, a través de este proyecto, en representación de Ingersoll Rand seremos capaces de ofrecer la solución que más se adecúe a las solicitudes del cliente en cuestión.

En el apartado de los cálculos, aplicando la ecuación de Darcy simplificada, podemos obtener fácilmente la pérdida de carga, tanto unitaria, como la de la instalación en conjunto y concluimos que dicha pérdida es tan pequeña que está garantizado el buen funcionamiento de la instalación pues en todo momento aseguramos la presión solicitada por cliente con una pérdida de 0.18 bar. Tanto las longitudes como los diámetros escogidos son válidos para el requerimiento de esta instalación y por tanto serán los escogidos según los cálculos obtenidos.

Por otra parte, haciendo un estudio mediante una auditoría a través del programa Intellisurvey llegamos a la conclusión de que los equipos solicitados inicialmente, en régimen de trabajo carga-vacío, no es la mejor de las soluciones pues la rentabilidad en caso de haber optado por la opción de compresores de velocidad variable es mucho mas económica. De ahí la nueva propuesta que lanzamos para sustituir los Sierra todo-nada por los variables Nirvana, ambos oil free, calidad solicitada por el cliente. De esta forma el cliente contará con la mejor instalación posible para su instalación particular con los mejores equipos de mercado y, lo mas importante, llegaremos a obtener un ahorro anual de 24.500 €, por lo que la amortización de la nueva máquina propuesta se será apenas de 5 años.

Con este proyecto fin de carrera, por tanto, lo que se pretende es enseñar, desde una perspectiva empresarial el proceder en la vida real desde que llega una petición de oferta hasta que se lleva a cabo una instalación previos cálculos ingenieriles que nos llevarán a cerciorarnos de que vamos a suministrar un producto que cumpla las expectativas del cliente.

Además, el novedoso aporte de este proyecto consiste en una auditoria energética que nos aporta una rápida visión del aprovechamiento de energía y ahorro de dinero, así como de las posibilidades de mejora de una instalación energética de aire comprimido para convertirla en lo mas eficiente posible.

6. BIBLIOGRAFÍA

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- **Curso de pneumatica U.P.C. J.J.de Felipe Blanch. Tema 5. Instalacion y redes de distribución del aire comprimido.**
- **Universidad EAFIT . Dpto.Ingeniería Mecanica. Esteban Hincapié, J.David Arboleda y Santiago Cardona.**
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- **Carnicer, E. Aire Comprimido Teoría y Cálculo de las Instalaciones. Ed. Gustavo Gili S.A., Barcelona, 1977.**
- **Horacio C., Quiroz E. Redes de Aire Comprimido**
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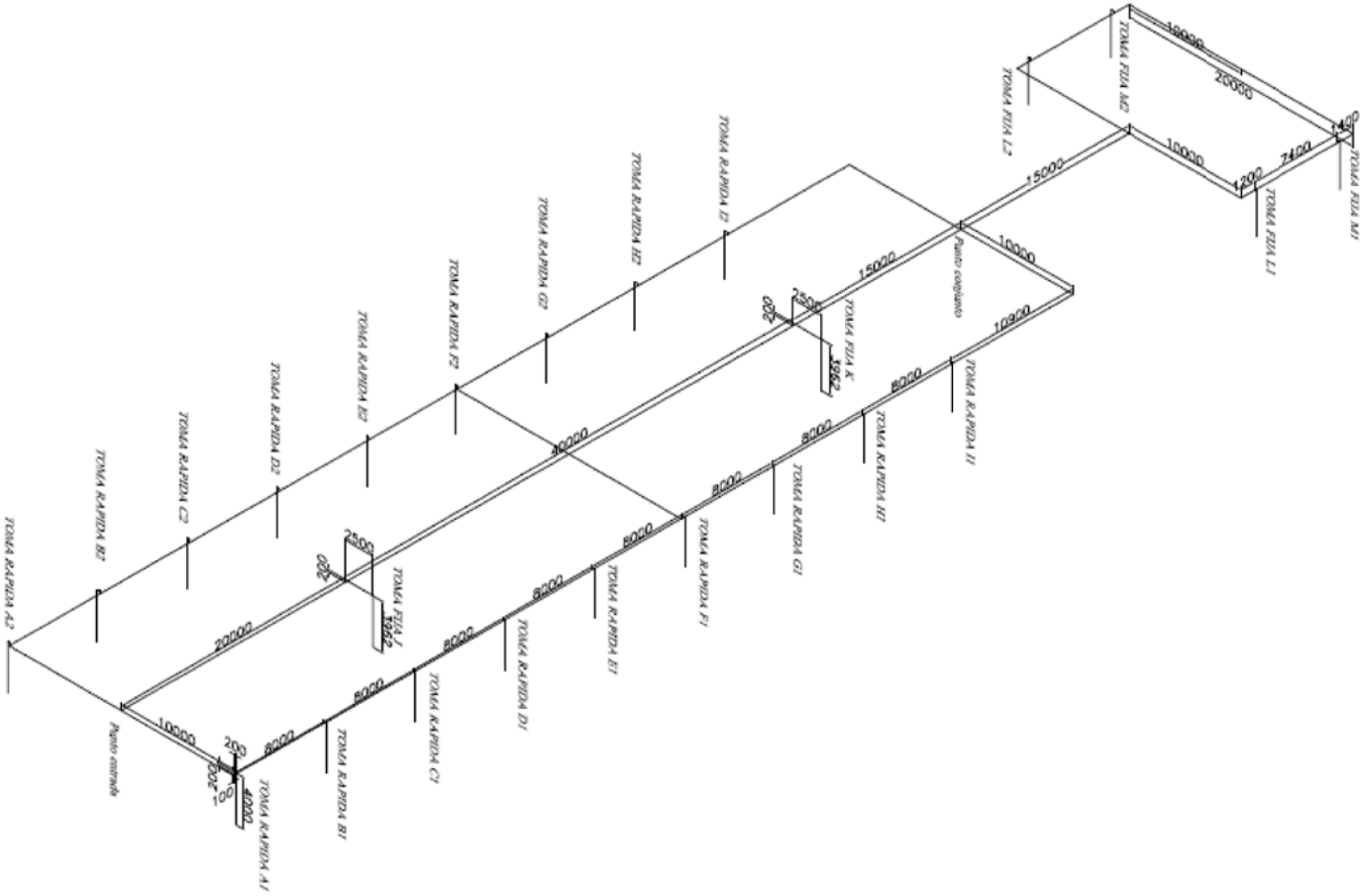
- **Instrucción tecnica complementaria referente a instalaciones de tratamiento y almacenamiento de aire comprimido. ITC MIE AP 17 (O.28-6-1988 BOE 8-7-1988)**
- **INGERSOLL RAND. CATALOGOS VARIOS.**
- **TALLERES VALSI. PLANOS**
- **Empresarios Agrupados.** Document No. 428-00-R-M-00410 Issue 1

Software utilizado:

- **Microsoft Office**
- **Microsoft Excel**
- **Adobe Proffesional**
- **Autocad 2010**
- **Intellisurvey 3.2**

7. ANEXOS

PLANOS



REV.	DESCRIPCION	FECHA	DIBUJADO	COMPROBADO	APROBADO
0	REVISION INICIAL	17-06-10	JRR	VS	VS

REVISIONES

CLIENTE : Ingersoll Rand Industrial Technologies

PROYECTO : SALA DE COMPRESORES
GENERACIÓN DE AIRE COMPRIMIDO PARA SALA DE RETOQUE

ESCALA : -:--

TITULO DE PLANO : PLANO DE TOMAS.DISTRIBUCION

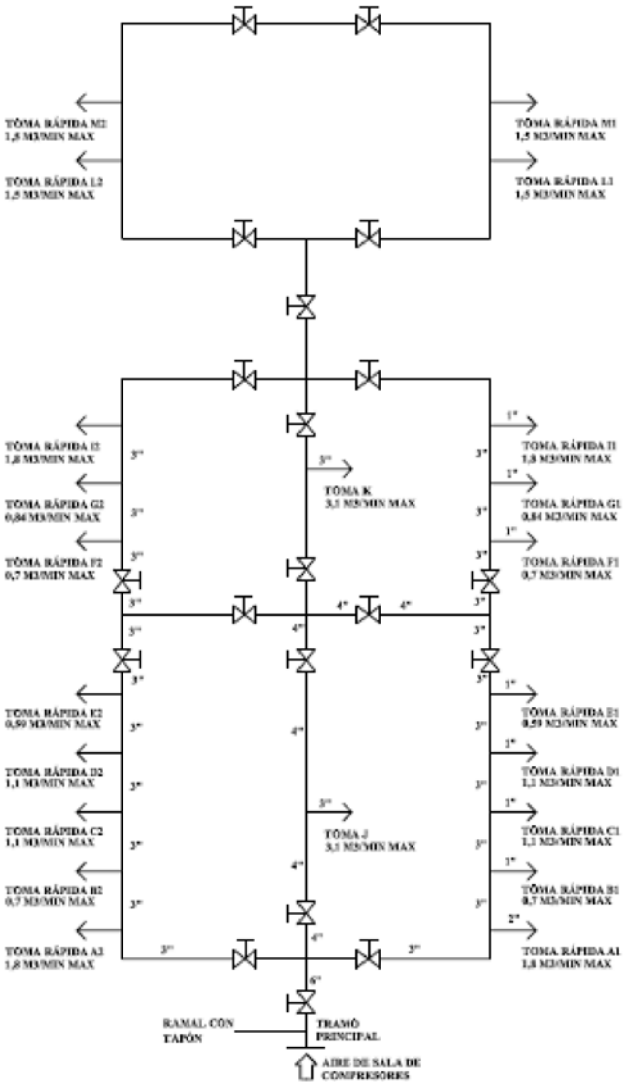
REFERENCIA : IR-ELD-03

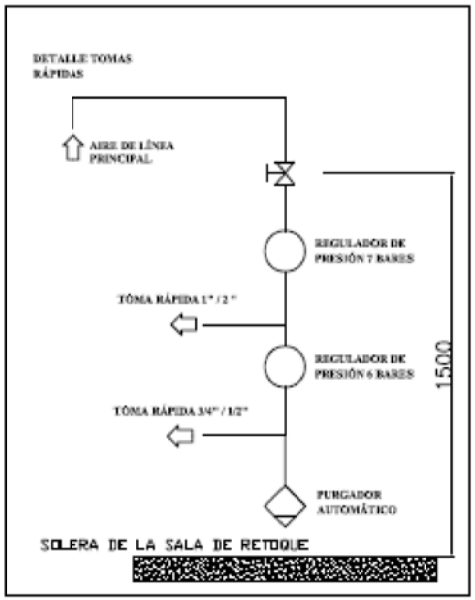
TAMAÑO ORIGINAL A3

ELEMENTO DE CONFIGURACION -

HOJA 1 DE 2

DIN A3 (420 x 297)





REV.	DESCRIPCION	FECHA	DIBUJADO	COMPROBADO	APROBADO
0	REVISION INICIAL	17-06-10	JRR	VS	VS

REVISIONES

CLIENTE : Ingersoll Rand Industrial Technologies

PROYECTO : SALA DE COMPRESORES
GENERACIÓN DE AIRE COMPRIMIDO PARA SALA DE RETOQUE

ESCALA : -:--

TITULO DE PLANO : PLANO DE TOMAS. DISTRIBUCION

REFERENCIA : IR-ELD-03

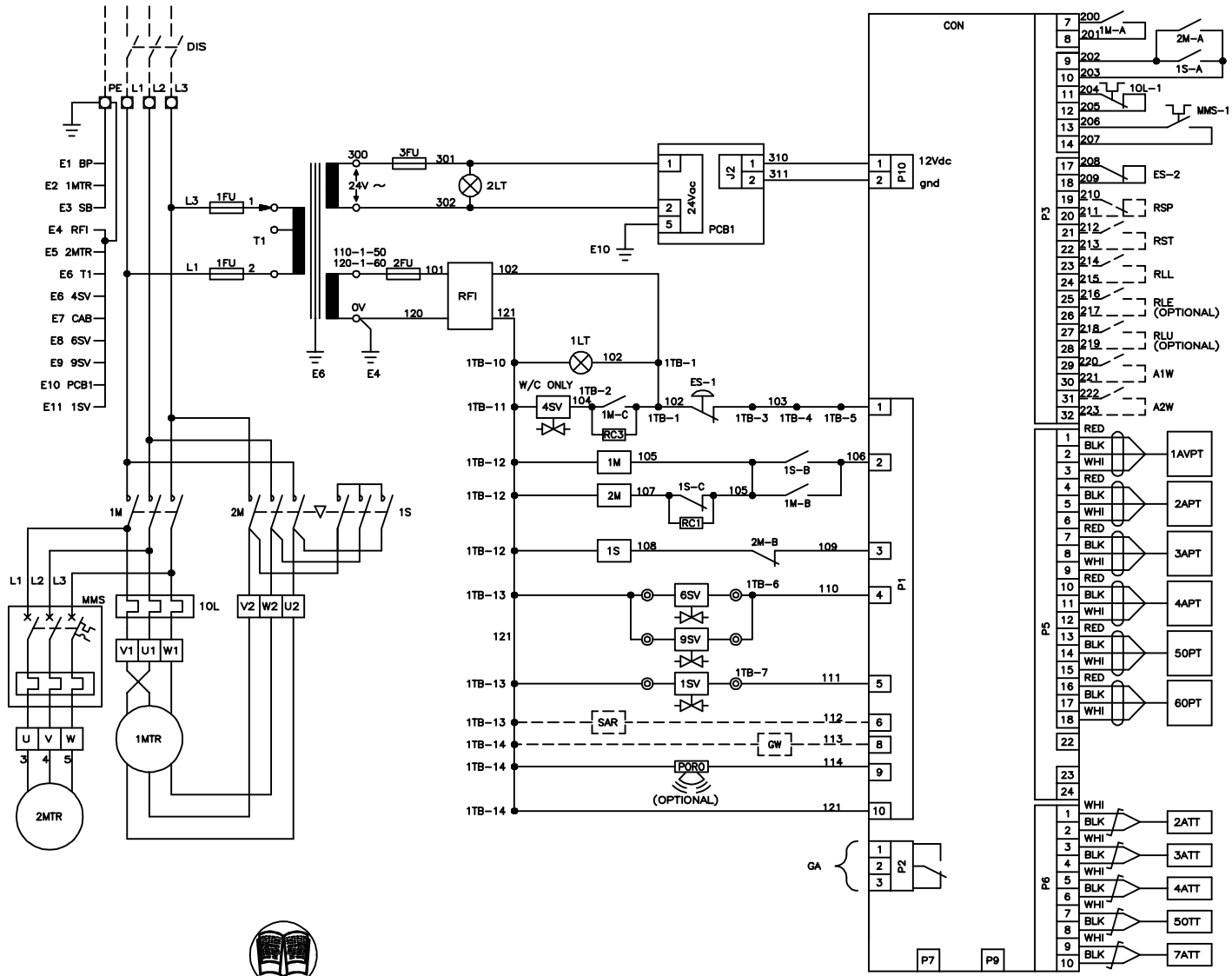
TAMAÑO ORIGINAL A3

ELEMENTO DE CONFIGURACION -

HOJA 2 DE 2

DIN A3 (420 x 297)

REVISIONS						
ZONE	REV	ECN	DESCRIPTION	DATE	DWN	APV
	A	409162	ORIGINAL RELEASE	28-Mar-02	DWH	02/073/GS
	B	600573	1 MTR Connections revised	03-Sep-03	AM	BD 012
	C	601581	Note: Re heater circuit added	09-Dec-04	AM	BD



FOR NOTES AND LEGEND
SEE OPERATORS MANUAL

SEE DRAWING 22576391
FOR HEATER CIRUIT SCHEMATIC
(LOW AMBIENT OPTION)

UNLESS OTHERWISE SPECIFIED, ALL DIMENSIONS ARE IN MILLIMETERS

REMOVE ALL BURRS AND SHARP CORNERS

CAD GENERATED DRAWING, NO MANUAL REVISIONS ALLOWED

MDUN CODE 4792

THIRD ANGLE PROJECTION

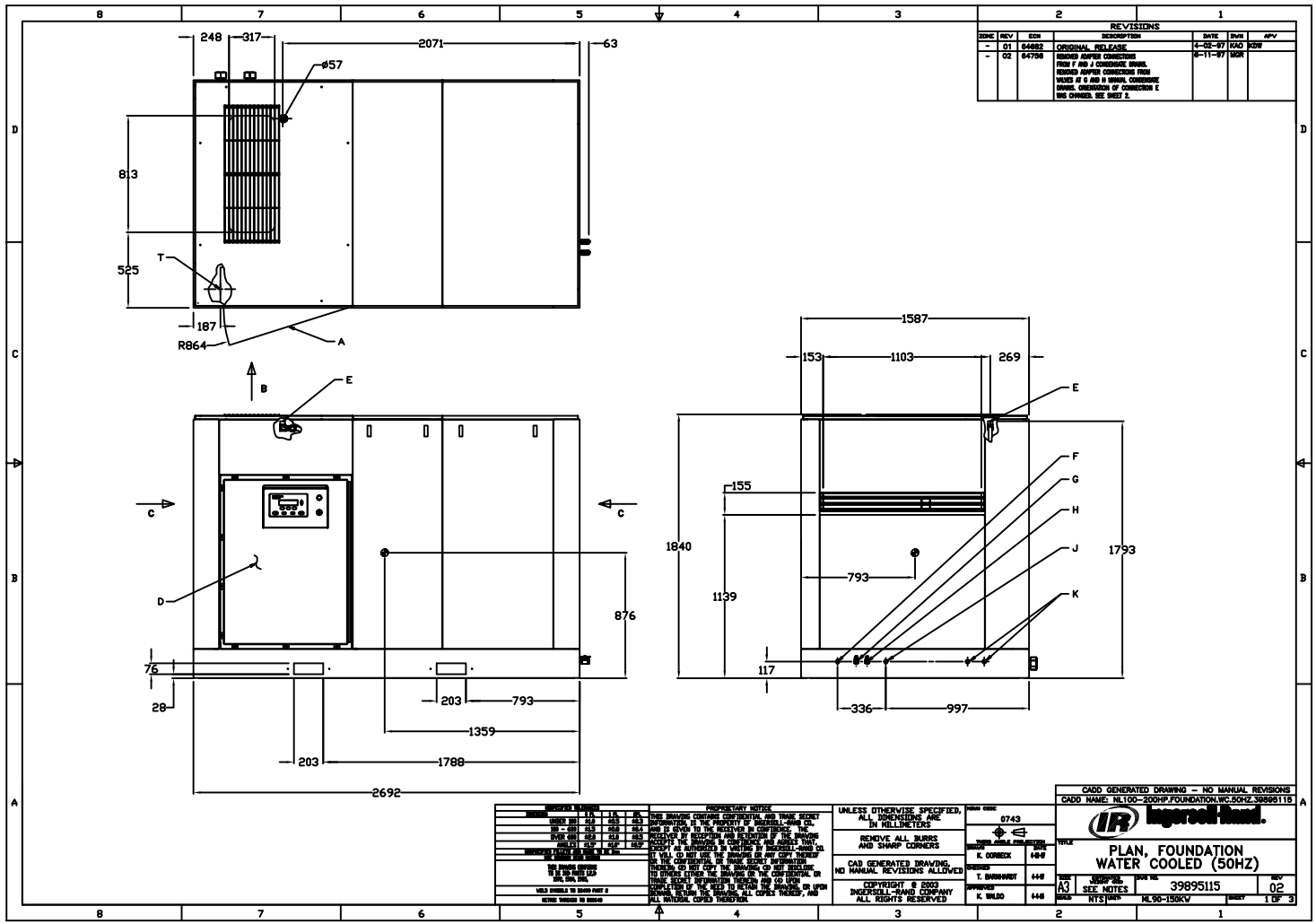
DRAWN	DWH	28-Mar-02
CHECKED	-	-
APPROVED	02/072/GS	28-Mar-02

Ingersoll-Rand. Air Solutions

TITLE: DECAL, ESA SIERRA (CD14) WIRING SCHEMATIC

SIZE	ESTIMATED WEIGHT (KGS)	DWG NO.	REV
A1	-	22130595	C

SCALE - UNIT: SIERRA (CD14) SHEET 1 OF 2



REVISIONS						
ZONE	REV	ECN	DESCRIPTION	DATE	DWN	APV
-	01	64682	ORIGINAL RELEASE	4-02-97	KAO	KDW
-	02	64756	REMOVED ADAPTER CONNECTIONS FROM F AND J CONDENSATE DRAINS. REMOVED ADAPTER CONNECTIONS FROM VALVES AT G AND H DRAIN. CONDENSATE DRAINS. ORIENTATION OF CONNECTION E WAS CHANGED. SEE SHEET 2.	6-11-97	MGR	

MATERIAL REMARKS			
	I.D.	O.D.	WALL
UNDER 300	44.8	48.3	1.65
300 - 400	41.5	48.3	3.4
OVER 400	42.9	48.3	2.7
ANGLE	41.9	48.3	3.2

PROPRIETARY NOTICE

THIS DRAWING CONTAINS CONFIDENTIAL AND TRADE SECRET INFORMATION. IT IS THE PROPERTY OF INGERSOLL-RAND CO. AND IS GIVEN TO THE RECEIVER IN CONFIDENCE. THE RECEIVER BY ACCEPTANCE AND RETENTION OF THE DRAWING ACCEPTS THE DRAWING IN CONFIDENCE AND AGREES THAT, EXCEPT AS AUTHORIZED IN WRITING BY INGERSOLL-RAND CO. IT WILL DO NOT USE THE DRAWING OR ANY COPY THEREOF OR THE CONFIDENTIAL OR TRADE SECRET INFORMATION THEREIN, DO NOT COPY THE DRAWING OR JUST DISCLOSE TO OTHERS EITHER THE DRAWING OR THE CONFIDENTIAL OR TRADE SECRET INFORMATION THEREIN AND DO UPON COMPLETION OF THE NEED TO RETAIN THE DRAWING, OR UPON DEMAND, RETURN THE DRAWING, ALL COPIES THEREOF, AND ALL MATERIAL COPIED THEREFROM.

UNLESS OTHERWISE SPECIFIED, ALL DIMENSIONS ARE IN MILLIMETERS

REMOVE ALL BURRS AND SHARP CORNERS

CAD GENERATED DRAWING, NO MANUAL REVISIONS ALLOWED

DRAWN BY: K. CORBECK 4-4-97
CHECKED: T. BARNHART 4-4-97
APPROVED: K. WALDO 4-4-97

CADD GENERATED DRAWING – NO MANUAL REVISIONS
CADD NAME: NL100-200HP_FOUNDATION.WC.50HZ.39895115

Ingersoll Rand

TITLE: PLAN, FOUNDATION WATER COOLED (50HZ)

SIZE: A3 | DRAWING NO.: SEE NOTES | DWG NO.: 39895115 | REV: 02
SCALE: NTS | WEIGHT: | SHEET: 1 OF 3
NEXT ASSY: ML90-150KV

REVISIONES					
REV.	DESCRIPCION	FECHA	DIBUJADO	COMPROBADO	APROBADO
0	REVISION INICIAL	17-03-11	JRR	VSM	VSM

Ingersoll Rand
Industrial Technologies

CLIENTE:

RENAULT

PROYECTO: SALA DE COMPRESORES
GENERACIÓN DE AIRE COMPRIMIDO PARA SALA DE RETOQUE

ESCALA: -:-

TITULO DE PLANO: PLANO DE DIMENSIONES GENERALES SM150WC

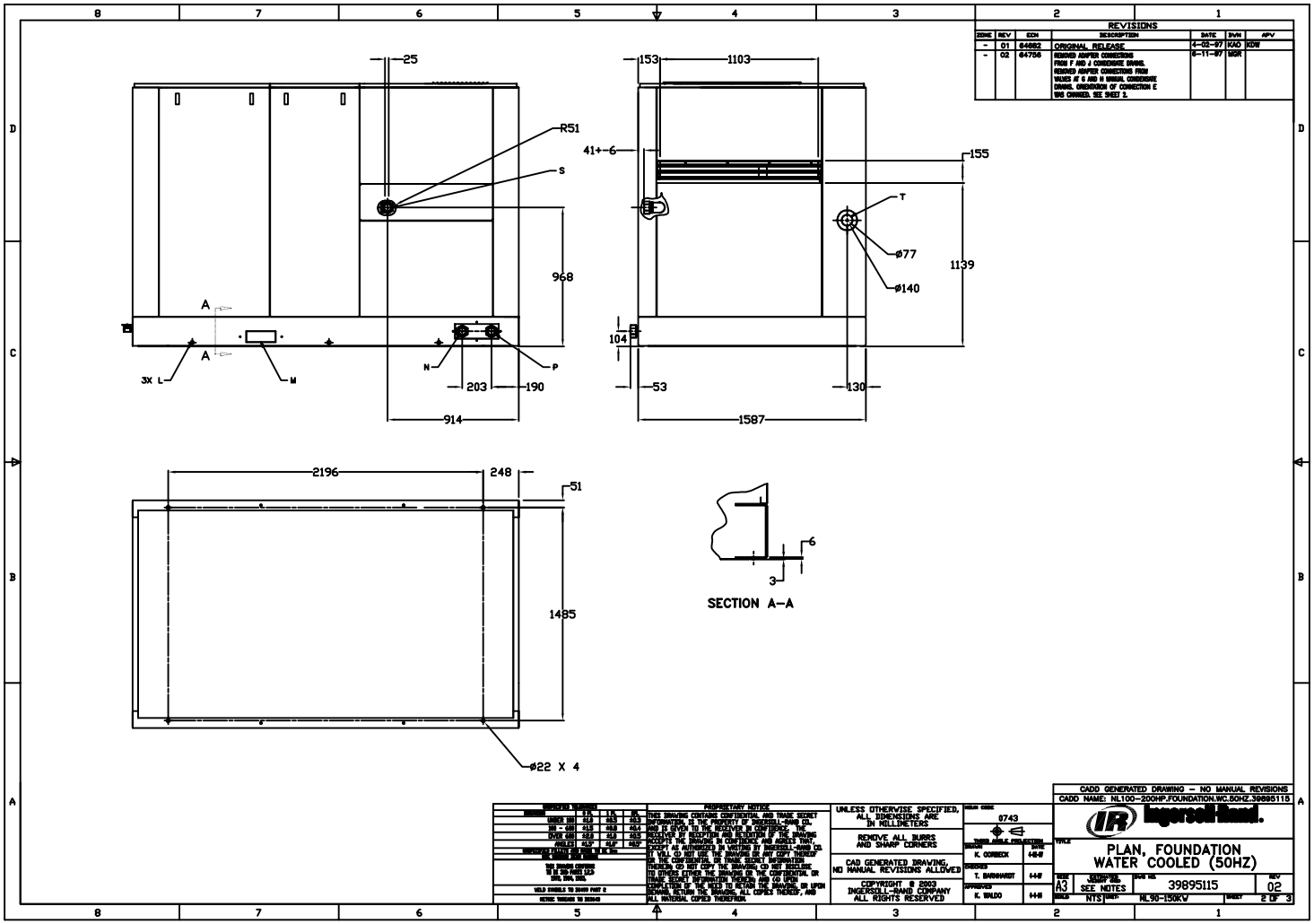
REFERENCIA: IR-GA-02

TAMAÑO ORIGINAL: A3

ELEMENTO DE CONFIGURACION: -

HOJA 1 DE 3

DIN A3 (420 x 297)



REVISIONS

ZONE	REV	ECN	DESCRIPTION	DATE	DWN	APV
-	01	64682	ORIGINAL RELEASE	4-02-97	KAO	KDW
-	02	64756	REMOVED ADAPTER CONNECTIONS FROM F AND J CONDENSATE DRAINS. REVISED ADAPTER CONNECTIONS FROM VALVES #1 & #2 AND H MANUAL CONDENSATE DRAINS. ORIENTATION OF CONNECTION E WAS CHANGED. SEE SHEET 2.	6-11-97	MSR	

PROPRIETARY NOTICE

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UNLESS OTHERWISE SPECIFIED, ALL DIMENSIONS ARE IN MILLIMETERS

REMOVE ALL BURRS AND SHARP CORNERS

CAD GENERATED DRAWING, NO MANUAL REVISIONS ALLOWED

MFG CODE 0743

THIRD ANGLE PROJECTION

DRAWN	K. CORBECK	4-8-97
CHECKED	T. BARNHARDT	4-8-97
APPROVED	K. WALDO	4-8-97

CADD GENERATED DRAWING — NO MANUAL REVISIONS

CADD NAME: NL100-200HP_FOUNDATION.WC.50HZ_39895115

Ingersoll Rand

TITLE: PLAN, FOUNDATION WATER COOLED (50HZ)

SIZE	DRAWING NO.	DWG NO.	REV
A3	SEE NOTES	39895115	02

SCALE: NTS WEIGHT: NL90-150KV SHEET 2 OF 3

REV.	DESCRIPCION	FECHA	DIBUJADO	COMPROBADO	APROBADO
0	REVISION INICIAL	17-03-11	JRR	VSM	VSM

REVISIONES

Ingersoll Rand
Industrial Technologies

CLIENTE :

RENAULT

PROYECTO : SALA DE COMPRESORES
GENERACIÓN DE AIRE COMPRIMIDO PARA SALA DE RETOQUE

ESCALA : —:—

TITULO DE PLANO : PLANO DE DIMENSIONES GENERALES SM150WC

REFERENCIA : IR-GA-02

TAMAÑO ORIGINAL A3

ELEMENTO DE CONFIGURACION -

HOJA 2 DE 3

DIN A3 (420 x 297)

REVISIONS						
ZONE	REV	ECN	DESCRIPTION	DATE	DWN	APV
-	01	64682	ORIGINAL RELEASE	4-02-97	KAO	KDW
-	02	64758	SEE SHEETS 1 AND 2	6-11-97	MGR	

NOTES:

1. WEIGHTS APPROXIMATE:
   90–110KW (ODP): 2920 – 3050 kg (6437 – 6724 LBS)
   132–150KW (ODP): 3220 – 3350 kg (7099 – 7385 LBS)
   90–150KW (TEFC): 3300 – 3400 kg (7275 – 7496 LBS)
2. COOLING AIR FLOW : 99 m^3/min – 3500 CFM.
3. PIPE CONDENSATE DRAIN LINES SEPARATELY TO AN OPEN DRAIN DUE TO DIFFERENCE IN DRAIN PRESSURES.
4. LUBE OIL FILL QUANTITY: 45 LITERS (12 GALLONS) APPROXIMATELY.
5. ALL DIMENSIONS IN MILLIMETERS (in).
6. TOLERANCE ON ALL DIMENSIONS: ±6 mm (±.25 INCH).
7. RECOMMENDED CLEARANCE ON THREE SIDES 914 (36.00). 1067 (42.00) FRONT OF CONTROL PANEL OR MINIMUM AS REQUIRED BY LATEST NATIONAL ELECTRICAL CODE OR APPLICABLE LOCAL CODES.
8. EXTERNAL PIPING SHALL NOT EXERT ANY UNRESOLVED MOMENTS OR FORCES ON UNIT. USE PIPE SIZE AS LARGE OR LARGER AT DISCHARGE LOCATION.
9. THERE SHOULD BE NO PLASTIC OR PVC PIPING ATTACHED TO THIS UNIT OR USED FOR ANY LINES DOWNSTREAM.
10. FORKLIFT HOLE COVERS MUST BE INSTALLED AFTER UNIT IS IN PLACE TO REDUCE NOISE AND INSURE PROPER COOLING OF PACKAGE.
11. FIELD INSTALLED DUCTING TO AND FROM COMPRESSOR CANNOT ADD MORE THAN 6 mm (0.25 INCHES) OF WATER TOTAL AIR RESISTANCE. GEAR BOX BREATHER MUST BE PIPED EXTERNAL.
12. UNIT HAS INTERNAL DISCHARGE CHECK VALVE, EXTERNAL CHECK VALVE NOT REQUIRED. ISOLATION VALVE IS RECOMMENDED.
13. COMPRESSOR SHOULD BE BOLTED TO THE FLOOR WITH FOUR 19 MM(.75) BOLTS LOCATED AS SHOWN ON SHEET 2 IN THE BOTTOM VIEW WITH IT BEING SEALED WITH CORK OR RUBBER.
14. DO NOT PIPE INTO A COMMON HEADER WITH A RECIPROCATING COMPRESSOR, UNLESS RECIP COMPRESSOR UTILIZES A DISCHARGE PULSATION DAMPENER.
15. ⊕ DENOTES CENTER OF GRAVITY.
16. SIZING OF ELECTRICAL COMPONENTS NOT SUPPLIED BY INGERSOLL–RAND IS THE RESPONSIBILITY OF THE CUSTOMER AND SHOULD BE DONE IN ACCORDANCE WITH THE INFORMATION ON THE COMPRESSOR DATA PLATE, NATIONAL AND LOCAL ELECTRICAL CODES.
17. WATER FLOW 182 l/min (48 GPM).

KEY

A	STARTER BOX DOOR CLEARANCE AREA. SEE NOTE 7.
B	COOLING AIR EXHAUST.
C	AIR INTAKE.
D	STARTER BOX.
E	1.00 INCH BSPT MALE BREATHER PIPING CONNECTION. SEE NOTE 11.
F	.50 INCH BSPT FEMALE AFTERCOOLER CONDENSATE DRAIN.
G	.25 INCH BSPT FEMALE AFTERCOOLER MANUAL CONDENSATE DRAIN. (SHIPPED LOOSE)
H	.25 INCH BSPT FEMALE INTERCOOLER MANUAL CONDENSATE DRAIN. (SHIPPED LOOSE)
J	.50 INCH BSPT FEMALE INTERCOOLER CONDENSATE DRAIN.
K	SEAL VENT OPENING. DO NOT PLUG.
L	BASE DRAINS.
M	FORK LIFT OPENINGS. SEE NOTE 10.
N	2.00 BSPT FEMALE WATER OUT CONNECTION.
P	2.00 BSPT FEMALE WATER IN CONNECTION.
S	2.00 BSPT FEMALE AIR DISCHARGE CONNECTION.
T	POWER INLET LOCATION FOR CONDUIT. SEE NOTE 16.

UNLESS OTHERWISE SPECIFIED, ALL DIMENSIONS ARE IN MILLIMETERS

REMOVE ALL BURRS AND SHARP CORNERS

CAD GENERATED DRAWING. NO MANUAL REVISIONS ALLOWED

MFGR CODE	0743
DRAWN	K. CORBEIX 6-6-97
CHECKED	T. BARNHART 6-9-97
APPROVED	K. WALDO 6-9-97

CADD GENERATED DRAWING – NO MANUAL REVISIONS
CADD NAME: NL100-200HP.FOUNDATION.WC.50HZ.39895115

Ingersoll Rand

TITLE: PLAN, FOUNDATION WATER COOLED (50HZ)

SIZE	UNLESS OTHERWISE SPECIFIED	DWG NO.	REV
A3	SEE NOTES	39895115	02
ISSUED	SCALE	SERIES	SHEET
NTS	NL90-150KW		3 OF 3

REV.	DESCRIPCION	FECHA	DIBUJADO	COMPROBADO	APROBADO
0	REVISION INICIAL	17-03-11	JRR	VSM	VSM

REVISIONES

Ingersoll Rand
Industrial Technologies

CLIENTE :

RENAULT

PROYECTO : SALA DE COMPRESORES
GENERACIÓN DE AIRE COMPRIMIDO PARA SALA DE RETOQUE

ESCALA : –:–

TITULO DE PLANO : PLANO DE DIMENSIONES GENERALES SM150WC

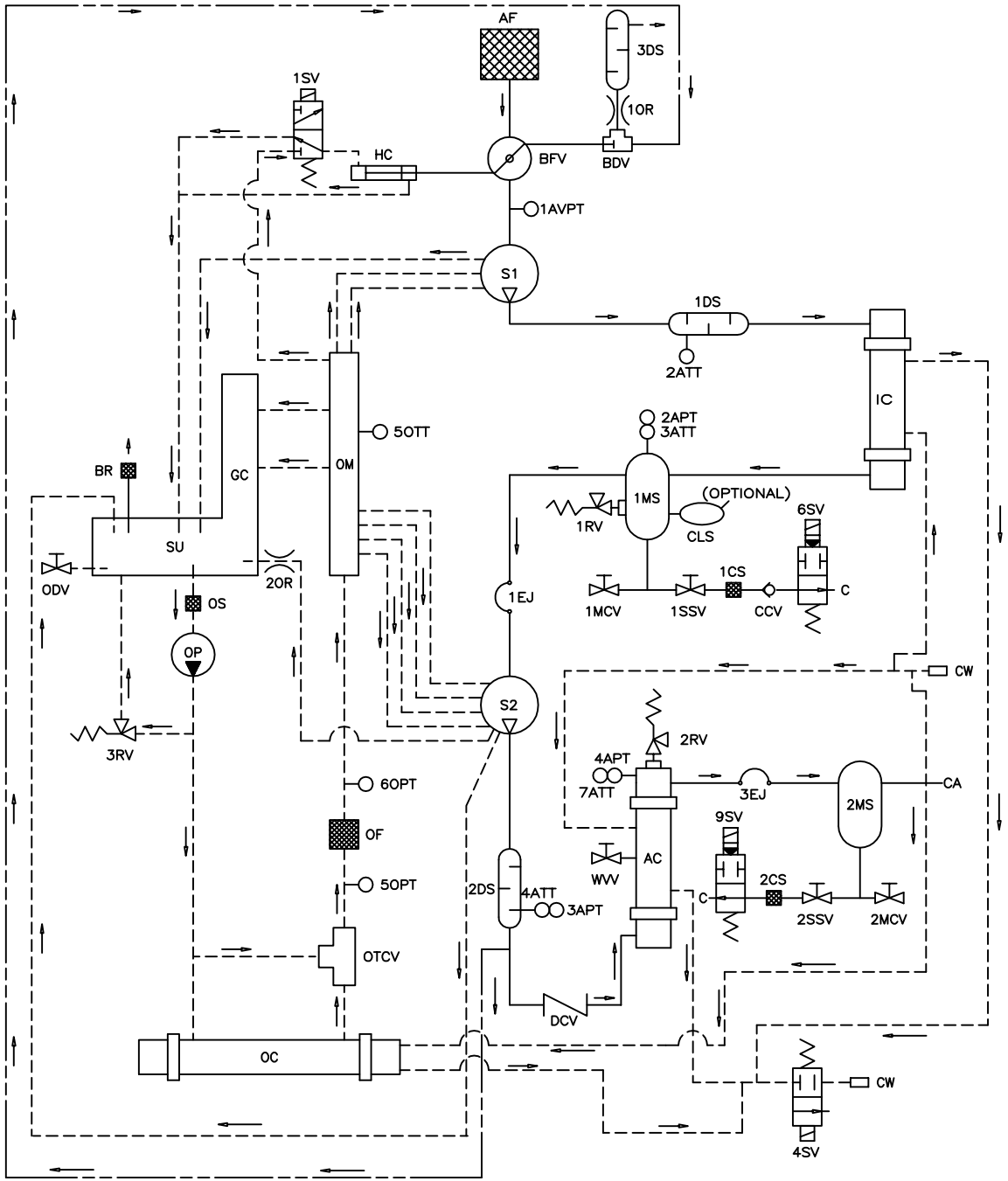
REFERENCIA : IR-GA-02

TAMAÑO ORIGINAL A3

ELEMENTO DE CONFIGURACION -

HOJA 3 DE 3

DIN A3 (420 x 297)



	01	64682	ORIGINAL RELEASE	4-2-97	BRW	KDW
	02	64756	CHANGED NOTES THROUGHOUT DRAWING. ADDED SHT2.	8-07-97	MGR	

SCHEM.FLP.NL100-200HP.WC.39897004

B.R.WYRICK 1-1-97
T. BARNHARDT 1-1-97
K. WALDO 1-1-97
42,99

PROCESS & INSTRUMENTATION DIAGRAM - WATER COOLED

64756 DNA 39897004 02
DNA NL125-200HP 1 2

LEGEND

ABBREV	DESCRIPTION	
S1	1ST COMPRESSOR STAGE	
S2	2ND COMPRESSOR STAGE	
GC	GEARCASE	
SU	SUMP	
AF	AIR FILTER	
AC	AFTERCOOLER	
BFV	BUTTERFLY THROTTLE VALVE	
HC	HYDRAULIC CYLINDER	
IC	INTERCOOLER	
OC	OIL COOLER	
OM	OIL MANIFOLD	
OF	OIL FILTER	
OTCV	OIL TEMP CONTROL VALVE	
OP	OIL PUMP	
ODV	OIL DRAIN VALVE	
OS	OIL STRAINER	
1OR	BLOWDOWN ORIFICE	
2OR	OIL FLOW ORIFICE	
BR	BREATHER	
BDV	BLOWDOWN VALVE	
DCV	DISCHARGE CHECK VALVE	
CW	COOLING WATER	
CA	COMPRESSED AIR	
C	CONDENSATE	
1DS	1ST STAGE DISCHARGE SILENCER	
2DS	2ND STAGE DISCHARGE SILENCER	
3DS	BLOWDOWN DISCHARGE SILENCER	
1EJ	INTERSTAGE EXPANSION JOINT	
3EJ	DISCHARGE EXPANSION JOINT	
1RV	INTERSTAGE SAFETY RELIEF VALVE	
2RV	DISCHARGE SAFETY RELIEF VALVE	
3RV	OIL PRESSURE RELIEF VALVE	
1MS	INTERSTAGE MOISTURE SEPARATOR	
2MS	DISCHARGE MOISTURE SEPARATOR	
1MCV	INTERSTAGE MANUAL CONDENSATE VALVE	
2MCV	DISCHARGE MANUAL CONDENSATE VALVE	
1SSV	INTERSTAGE STRAINER SERVICE VALVE	
2SSV	DISCHARGE STRAINER SERVICE VALVE	
1CS	INTERSTAGE CONDENSATE STRAINER	
2CS	DISCHARGE CONDENSATE STRAINER	
CCV	CONDENSATE CHECK VALVE	
CLS	CONDENSATE LEVEL SWITCH (OPTIONAL)	
1SV	LOAD SOLENOID VALVE	
4SV	WATER SOLENOID VALVE	
6SV	INTERSTAGE CONDENSATE SOLENOID VALVE	
9SV	DISCHARGE CONDENSATE SOLENOID VALVE	
WV	WATER VENT VALVE	
1AVPT	VACUUM PRESSURE TRANSDUCER	RANGE: 0 TO 15 PSI
2APT	AIR PRESSURE TRANSDUCER	RANGE: 0 TO 100 PSI
3APT	AIR PRESSURE TRANSDUCER	RANGE: 0 TO 200 PSI
4APT	AIR PRESSURE TRANSDUCER	RANGE: 0 TO 200 PSI
5OPT	OIL PRESSURE TRANSDUCER	RANGE: 0 TO 200 PSI
6OPT	OIL PRESSURE TRANSDUCER	RANGE: 0 TO 200 PSI
2ATT	AIR TEMPERATURE TRANSDUCER (RTD)	RANGE: −18 TO 266 °C
3ATT	AIR TEMPERATURE TRANSDUCER (THERMISTER)	RANGE: −18 TO 120 °C
4ATT	AIR TEMPERATURE TRANSDUCER (RTD)	RANGE: −18 TO 266 °C
7ATT	AIR TEMPERATURE TRANSDUCER (THERMISTER)	RANGE: −18 TO 120 °C
5OTT	OIL TEMPERATURE TRANSDUCER (THERMISTER)	RANGE: −18 TO 120 °C

PIPING LEGEND

- AIR PIPING
- OIL PIPING
- CONDENSATE PIPING
- WATER PIPING
- BLOWDOWN PIPING

01	64682	ORIGINAL RELEASE	4-2-97	BRW	KDW
02	64756	CHANGED NOTES THROUGHOUT DRAWING. ADDED SHT2.	8-07-97	MGR	

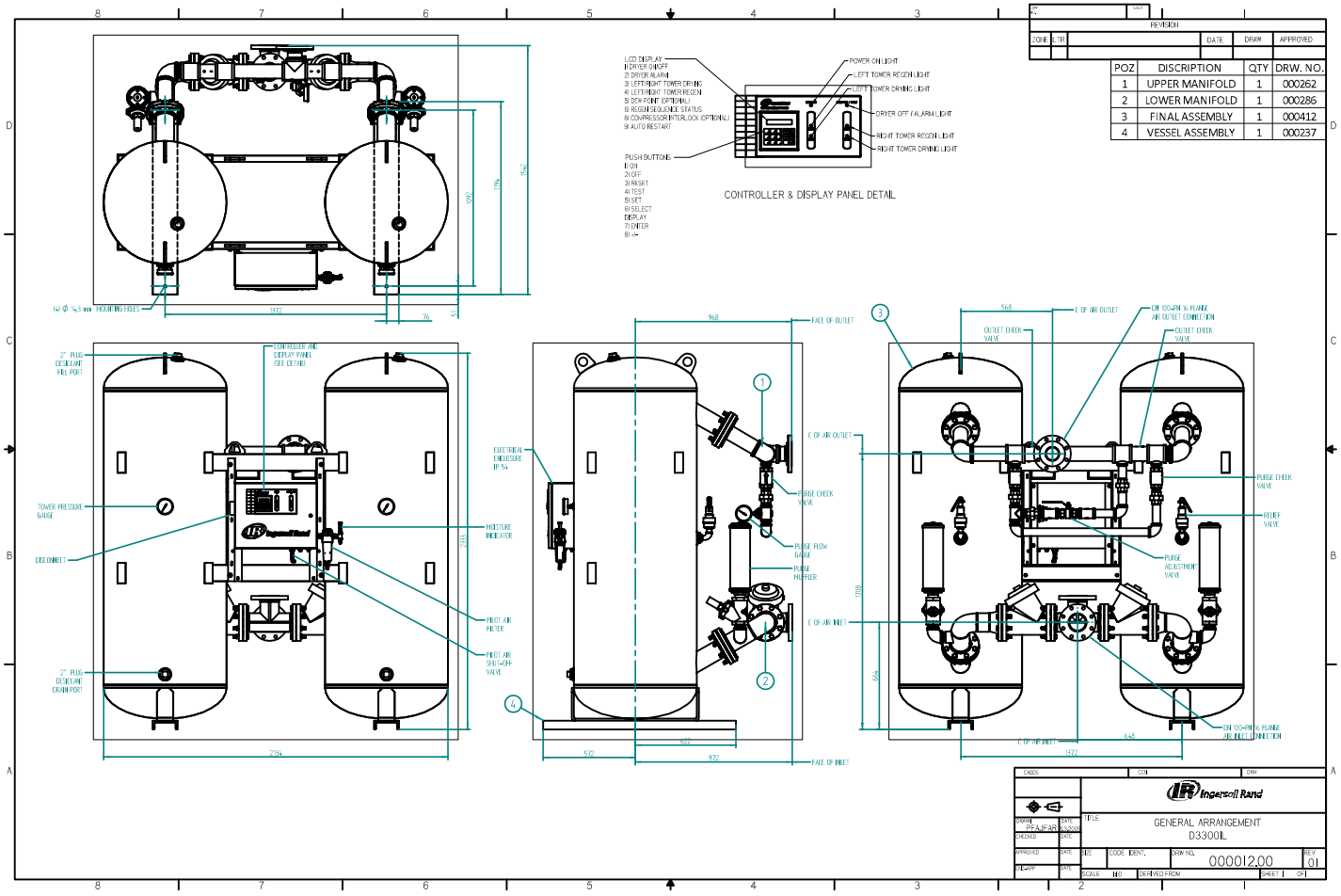
SCHEM.FLP.NL100-200HP.WC.39897004

B.R.WYRICK 1-1-97
T. BARNHARDT 1-1-97
K. WALDO 1-1-97

42,99

PROCESS & INSTRUMENTATION DIAGRAM - WATER COOLED

64756 DNA 39897004 02
DNA NL125-200HP 2 2



POZ	DISCRIPTION	QTY	DRW. NO.
1	UPPER MANIFOLD	1	000262
2	LOWER MANIFOLD	1	000286
3	FINAL ASSEMBLY	1	000412
4	VESSEL ASSEMBLY	1	000237

REV	DESCRIPCION	FECHA	DIBUJADO	COMPROBADO	APROBADO
0	REVISION INICIAL	17-06-11	JRR	VSM	VSM

REVISIONES

Ingersoll Rand
Industrial Technologies

CLIENTE :

PROYECTO: SALA DE COMPRESORES
GENERACIÓN DE AIRE COMPRIMIDO PARA SALA DE RETOQUE

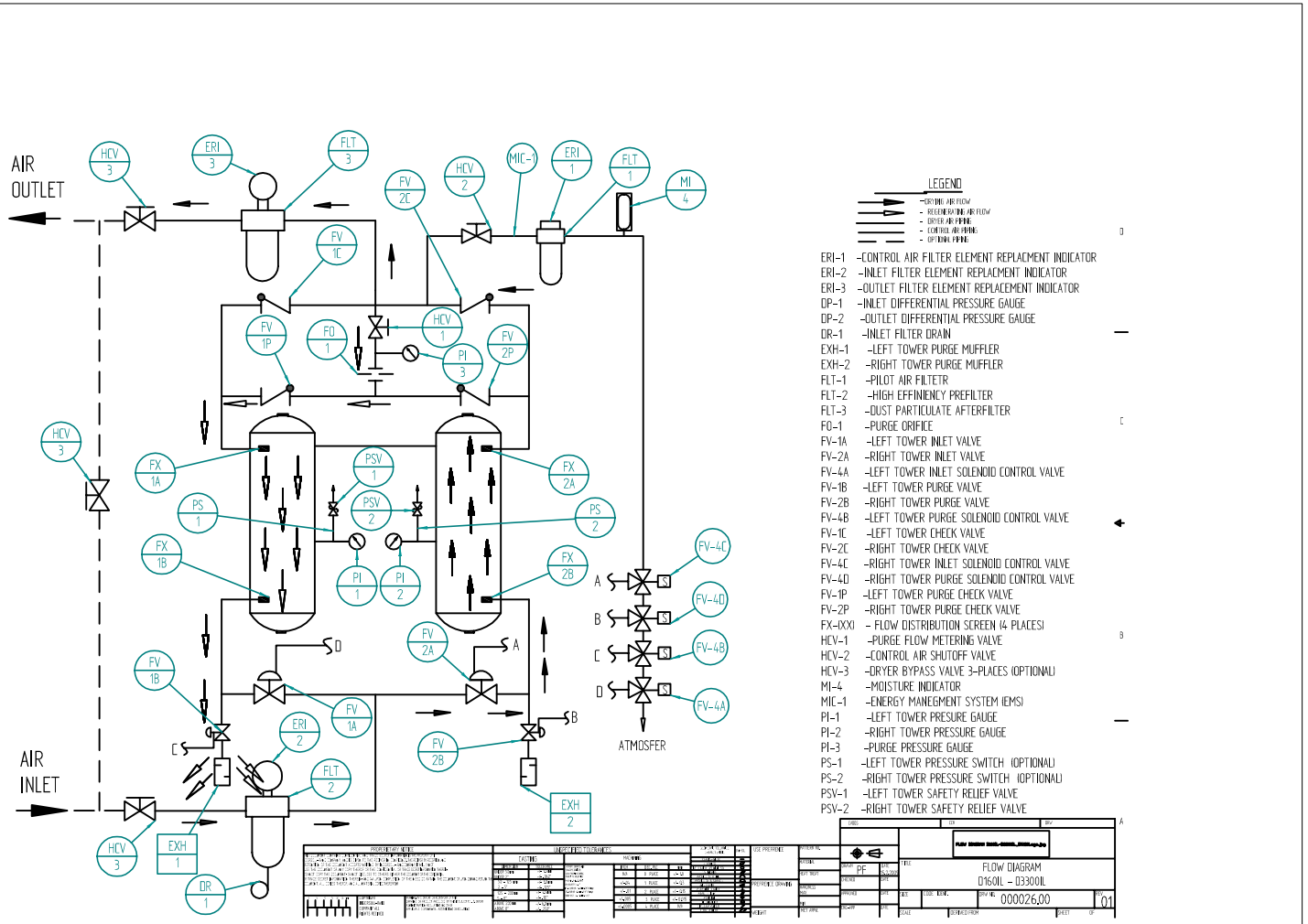
ESCALA : --:--

TÍTULO DE PLANO: PLANO DE DIMENSIONES GENERALES SECADOR D3300IL

REFERENCIA : IR-GA-03

TAMAÑO ORIGINAL A3

HOJA 1 DE 1



REV	DESCRIPCION	FECHA	DIBUJADO	COMPROBADO	APROBADO
0	REVISION INICIAL	19-06-11	JRR	VS	VS

REVISIONES

Ingersoll Rand
Industrial Technologies

CLIENTE:

PROYECTO: SALA DE COMPRESORES
GENERACIÓN DE AIRE COMPRIMIDO PARA SALA DE RETOQUE

ESCALA: --:--

TITULO DE PLANO: DIAGRAMA DE INSTRUMENTACIÓN Y PROCESO SECADOR D3300IL

REFERENCIA: IR-PID-02

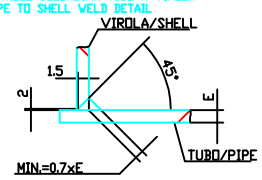
TAMAÑO ORIGINAL: A3

ELEMENTO DE CONFIGURACIÓN

HOJA 1
DE 1

WHEN HEAD IS CAP THE ANGLE WILLBE 75º

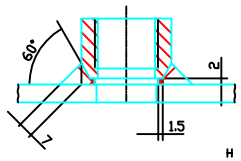
DETALLE SOLDADURA TUBO A VIROLA
PIPE TO SHELL WELD DETAIL



E

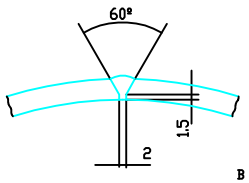
BRIDA FLANGE ANSI 75º

DETALLE SOLDADURA MEDIO MANGUITO A VIROLA
HALF COUPLING TO SHELL WELD DETAIL



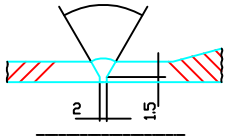
H

DETALLE SOLDADURA LONGITUDINAL
LONGITUDINAL WELD DETAIL



B

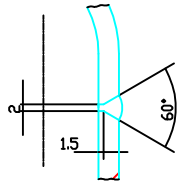
DETALLE SOLDADURA BRIDA CON CUELLO A TUBO
WELDING NECK FLANGE TO PIPE WELD DETAIL



BRIDA/FLANGE DIN 60º
BRIDA FLANGE ANSI 75º

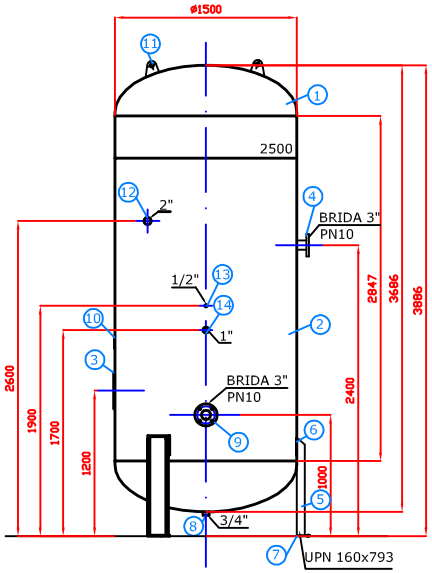
D

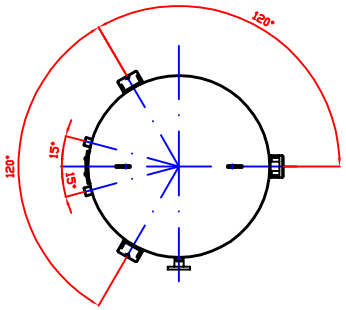
DETALLE SOLDADURA VIROLA A FONDO
SHELL TO HEAD WELD DETAIL



CUANDO EL FONDO ES CAP EL ANGULO SERA 75º
WHEN HEAD IS CAP THE ANGLE WILLBE 75º

A





DATOS DEL DISEÑO

CODIGO: ASME VIII DIV.1
VOLUMEN: 6000L
PRESION DE DISEÑO: 10 BAR
PRESION DE PRUEBA: 14.3 BAR
TEMPERATURA: -10 +100 ºC
ESPESOR DE CORROSION: 1 mm
COEFICIENTE DE JUNTA: 0.7

MARCA	DESCRIPCION	Nº PIEZAS	DIMENSIONES	MATERIAL
14	MANGUITO	1	1"	ST 52
13	MANGUITO	1	1/2"	ST 52
12	MANGUITO	1	2"	ST 52
11	OREJETA	2	110x120x15 mm	S355J2+N
10	SOPORTE PLACA CARACTERISTICAS	1	110 x 90x 2	S355J2+N
9	BRIDA 3" PN10	1	5"	C228 ST37.0
8	MANGUITO	1	3/4"	ST 52
7	PIE PATA	3	PIE:180x100x7 C/T Ø 22	S275JR
6	REFUERZO	3	180 x 160 x 6	S355J2+N
5	PATA	3	UPN 160x761	S275JR
4	BRIDA 3" PN10	1	5"	C228 ST37.0
3	REGISTRO	1	400x300	ST 52.3
2	VIROLA	1	4684x2847x9 mm	S355J2+N
1	F.KORBBOGEN	2	Ø1500x8.4 mm	S355J2+N

	FECHA	NOMBRE
DIBUJADO	24-03-10	R. FDEZ
MODIFICADO		

Cliente: INGERSOLL RAND
Referencia plano: VAC-6000-10 BAR

ESCALA 1/20

DEPOSITO VAC 6000/10 BAR
Ø 1500 mm

VS TALLERES VALSI S.A.L.
Pº de la Acacia, 30.1 (Polg. Ind. La Mora)
47193 La Cistérniga.VALLADOLID (ESPAÑA)
Telf. + 34 983 40 24 29
email: valsi@talleresvalsi.com
www.talleresvalsi.com

REV.	FECHA	DIB.	DESCRIPCION	VERIF.	APROB.
-	-	-	-	-	-
-	-	-	-	-	-
-	-	-	-	-	-
-	-	-	-	-	-
1	28/10/11	JRR	Revisión incial	VSM	VSM

REFERENCIA PROYECTO

REFERENCIA PROYECTO: OXC

PLANO DE DIMENSIONES GENERALES
CALDERIN VAC 6m3 10 Bar

Nº PLANO		
OXC-18-PLN-56-08001		
ESCALA	HOJA	REVISION
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ESPECIFICACIONES EA

EMPRESARIOS AGRUPADOS

CLASSIFICATION

Contains information for the design of structures, systems or components: Yes ☒ No ☐

Design verification : Not applicable ☐ Head of OU/Supervisor ☒ Verifier Level 1 ☐ Level 2 ☐

CONTROL OF MODIFICATIONS

Issue	Modifications
1	N/A

PRELIMINARY OR PENDING INFORMATION

Issue	Paragraphs	Subject	Status
1	Appendix B	Compressed Air Equipment Datasheets	Preliminary

DISTRIBUTION

External	Internal	No. copies/Format
COBRA		1/Electronic file
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1. BACKGROUND AND SCOPE

The work covered by this product specification, *Air Compressors Technical Specification*, document No. 428-00-I-M-27200, includes the supply of said equipment for Lares Combined Cycle Power Plant.

The project shall be built by the Consortium “General-Electric-Cobra-CME” in the vicinity of Lares-Figueira da Foz, in the district of Coimbra (Portugal), in an existing calcium carbonate old factory site. The Station shall be configured on a two (2) General Electric 109FB single-shaft combined cycle gas turbine basis. Each single-shaft unit shall comprise a gas turbine, a multi-pressure condensing steam turbine and a generator on the same shaft, together with a multi-pressure heat recovery steam generator (HRSG) and all associated auxiliaries.

The purpose of this Specification is to define the scope and the minimum requirements for the design, materials, fabrication, inspection, testing and delivery to the site of the compressed air equipment.

2. DEFINITIONS

2.1 CONTRACTUAL TERMS

The contractual terms applicable to the equipment and services to be supplied shall be in accordance with those defined in the bid request.

2.2 TECHNICAL TERMS

The technical terms used in these documents shall be in accordance with those defined in European Standard EN-45510, *Guide for Procurement of Power Station Equipment*.

3. PROJECT GENERAL DESCRIPTION

3.1 PROJECT ORGANISATION

The Owner of Lares Combined Cycle Power Plant is Energia de Portugal (EDP). The main equipment will be supplied by General Electric International, Inc.

3.2 SITE CHARACTERISTICS

The site is located in Lares, on the right bank of Mondego river, 6 km East of Figueira de Foz city, and about 190 km North the city of Lisboa. This place belongs to the township Vila Verde and county of Figueira da Foz in the district of Coimbra.

The site is bordered on the North by the railway, at east by a small water line and at the south and west by the M600 road. For East, nearby the Mondego river, it passes a water canal associated with the regularization of *Baixo Mondego*.

3.2.1 Seismic Requirements

In accordance with the distribution of seismic intensities elaborated by the National Institute of Meteorology and Geophysicist, the Lares Region is inserted in a zone C of maximum seismic intensity of degree VII on the international scale and soil type III

The site is in the seismic zone C of the Regulations on Safety and Actions for Buildings and Bridge Structures (Decree-Law no. 235/83 of 31st May), with a coefficient α = 0.5, corresponding to a low seismic risk.

3.2.2 Site Environmental Conditions

Item	Data
Height above sea level (m)	7
Barometric pressure (bar,a)	1.013
Ambient temperature (°C)	
Absolute maximum	38,6
Mean	14.8

Item	Data
Absolute minimum	-2.5
Relative humidity (%)	
Absolute maximum	100
Mean	80
Absolute minimum	13
Snow load (kg/m^2)	0

3.3 AIR COMPRESSORS ROOM ENVIRONMENTAL CONDITIONS

The Compressed Air System will be installed inside the Air Compressors Room, which will have the following ambient conditions:

Item	Data
Ambient Temperature inside Turbine Bldg (ºC)	
Maximum	40
Minimum	6
Ambient Relative Humidity inside Turbine Bldg (%)	Not controlled

3.4 MAIN FUNCTION OF THE EQUIPMENT

The purpose of the compressed air system is to provide continuous supply of compressed, filtered, dry and oil-free air for the operation of pneumatic instruments and the supply of pneumatic actuators. It will also supply service air to all plant intakes for the operation of pneumatic machinery and other compressed air needs.

3.5 INTERFACES AND USER SERVICES

The compressed air system supplier shall take into account the equipment and service interfaces with all the elements supplied by the Purchaser or other parties. The main interfaces to be considered by the Supplier for each unit are indicated below:

- Mechanical interfaces
  - Connection to the prefilter outlet pipe for service air piping connection
  - Connection to the postfilter outlet pipe for instrumentation air piping connection
  - Anchor and support elements
- Electrical interfaces
  - Two 400 V, three-phase without neutral, 50 Hz power supplies will be provided, one for each power supply panel
  - Two 230 V, phase plus neutral, 50 Hz redundant safe UPSs will be provided from the Plant to the Control Panel, exclusively for PLC supply, according to document 428-00-R-I-00400, *Specification of DCS Interfaces with Package Plants*
- I&C interfaces
- General layout of the compressed air system equipment

3.6 EQUIPMENT IDENTIFICATION

The Lares Combined Cycle Power Plant follows an identification system based on the KKS system (Identification System for Power Stations) edited by the VGB Technical Committee.

The air compressor identification shall be 00SCA10/20AN001. All main equipment items, valves, interconnections and control components will be permanently identified with the project identification number. All identification numbers of the above components will be defined by the Supplier in accordance with the above criteria and sent to the Purchaser for comments.

All numbers shall be engraved on stainless steel or laminated phenolic tags and shall be permanently attached to the equipment items. This identification shall be maintained in all the documents (drawings, list, manuals, data sheets, etc.) in which the equipment items are mentioned.

A nameplate shall be affixed to each all of the equipment items and contain the necessary information. These nameplates shall be manufactured in stainless steel and engraved with block lettering of a size legible from working position.

The air compressor system nameplates shall contain, at least, the following information:

- Project
- Equipment identification number
- Manufacturer, type and size
- Serial number
- Flow (Nm^3/h)
- Weigh (kg)
- Design pressure
- Design temperature
- Test pressure
- CE marking

The air compressor items must include a second plate or tag for identification. This plate shall be easily visible and have three text rows: the first shall indicate the KKS number of the equipment (capital letters), while the second and third shall include a description of said equipment. The text shall be written in English, and the number of characters per row shall be twenty.

4. REFERENCE DRAWINGS, SPECIFICATIONS AND DOCUMENTS

Document No.	Title
428-00-I-M-27700	*Painting Specification*
428-00-R-I-00400	*Specification of DCS Interfaces with Package Plants*
428-00-R-I-00500	*I&C Design Criteria for and Mechanical Equipment*
428-00-R-E-00320	*Electrical Requirements for Mechanical Equipment and Package Plants*
428-00-R-M-00410	*Technical Requirements for Piping and valves in package plants*

5. APPLICABLE CODES AND STANDARDS

The Supplier shall comply with all local laws and requirements applicable to the Purchaser during the validity period of the contract. Particular attention shall be paid to compliance with the *CE Directive for Pressure Equipment, Directive 97/23/CE*. All equipment shall have CE markings.

The Supplier shall draw the Purchaser's attention to any conflict between the requirements of this Specification and its references. Should the requirements of this Specification conflict with the requirements of the Codes and Standards referenced herein or with the applicable Portuguese codes, standards and local regulations, then the more stringent requirements shall apply. Should there be any difference of opinion with regard to interpretation of requirements, the Purchaser shall be judge of the requirements and his interpretation shall rule.

The design, materials, fabrication, tests, cleaning, coating and packing for shipment of all equipment and components included in the scope of this document shall comply with the applicable codes and standards set out below the latest edition. In the event of conflict between any of the codes and standards listed, the most stringent requirement shall apply.

In addition to the codes and standards required in this specification, the instrumentation and electrical motor together with its components shall comply with the codes and standards required in specification No. 428-00-R-I-00500, *I&C Design Criteria for Mechanical Equipment* and in No. 428-00-R-E-00320 *Electrical Requirements for Mechanical Equipment and Package Plants.*

- Standards of the Hydraulic Institute (HIS)
- American Society of Mechanical Engineers (ASME)
  - ASME II – Material Specifications
  - ASME V – Non-Destructive Examinations
  - ASME VIII Division I, - Pressure Vessels
  - ASME IX – Welding and Brazing Qualifications
- American National Standards Institute (ANSI/ASME)
  - ANSI/ASME B16.5 – Pipe Flanges and Flanged Fittings

- ANSI/ASME B16.9 – Factory-made Wrought Steel Butt-Welding Fittings
- ANSI/ASME B16.11 – Forged Steel Fittings, Socket-Welding and Threaded
- ANSI/ASME B16.34 – Valves Flanged, Thread and Welding Ends
- ANSI/ASME B36.10 – Welded and Seamless Wrought Steel Pipe
- ANSI/ASME B31.1-1 – Power Piping
- ANSI/ASME PTC-36-1985 Measurement of Industrial Sound

- American Society for Testing and Materials (ASTM)
- Standards of the American Welding Society (AWS)
- Instrument Society of America (ISA)
  - ISA-S7.3 - 1975 Quality Standard for Instrument Air
  - ISA-RP7.7 - 1984 Recommended Practice for Producing Quality Instrument Air
- National Electrical Manufacturers Association (NEMA)
- National Electrical Code (NEC)
- Insulated Power Cable Engineer Association (IPCEA)
- International Electrotechnical Commission (IEC)
- Anti-friction Bearing Manufacturers Association (AFBMA)
- American Gear Manufacturers (AGMA)
- ISO Standards
  - Acoustic-Test code form measurements of airborne noise emitted by rotating electrical machinery, ISO 1680/1
  - ISO 1940 Mechanical vibration – Balance quality requirements of rigid rotors
  - 9000 Series ISO Standards

- ISO 10816 Mechanical vibration – Evaluation of machine vibration by measurement on non-rotating parts
- ISO 11342 Mechanical vibration – Methods and criteria for balancing of flexible rotors
- ISO 7919 Mechanical vibration of non-reciprocating machines-Measurements on rotating shafts and evaluation criteria
- ISO 2151 Acoustic-Noise test code for compressors and vacuum pumps

- Steel Structures Painting Council (SSPC)
- Swedish Standard Institution (SIS)
- National Association of Corrosion Engineers (NACE)
- European Directives
  - Machine Directive 98/37/EC
  - Low Voltage Directive 73/23/EC
  - Electromagnetic Directive 89/336/EC and 2004/108/EC
  - CE Marking Directive 93/465/EC
  - Pressure Equipment Directive 97/23/EC

The Supplier shall comply with other EU Directives that have been transferred to Portuguese legislation.

As a rule, the USA industrial standards shall be applicable. However, they may be substituted by equivalent internationally recognised standards such as DIN, BSI, AFNOR, JIS, etc.

Should the prospective Supplier decide to employ equivalent standards as an alternative to USA ones, he shall indicate them accordingly; in this case, the Purchaser reserves the right to include additional requirements.

It shall be the Supplier's responsibility to be, or to become, knowledgeable of the requirements of the codes and standards set out above. Any changes or alterations to the equipment required for compliance with these codes and standards shall be at the expense of the Supplier.

6. SCOPE OF SUPPLY AND SERVICES

6.1 GENERAL

The Supplier shall be responsible for furnishing the complete design, procurement of materials and equipment, manufacturing, inspecting and testing in works, cleaning, coating, packing protection for shipment and transport to the site of the Compressed Air System as detailed in Section 6.2.

The Supplier shall also be responsible for submission to the Purchaser of information, data, calculations, drawings, curves, procedures, certificates and other documents, as may be required by Portuguese regulation and by this specification, the applicable codes and standards and other reference documents specified herein.

Should the Supplier wish to subcontract any of the work covered by this specification, it is his responsibility to ensure that his subcontractors are made fully aware of the relevant requirements of this specification. The Purchaser has the right of approval of proposed subcontractors.

6.2 EQUIPMENT AND COMPONENTS TO BE SUPPLIED

6.2.1 General

The complete supply of a compressed air system comprises all the equipment, components, piping, valves, accessories, cables, and instrumentation and control needed to provide the compressed air flow and quality required in this specification. The supply is complete for all the installation, and the limits of supply are at the prefilter outlet pipe for service air outlet connections and the postfilter outlet pipe for instrument air outlet connections

All the compressed air plant will be installed inside the Air Compressors Room. The compressed air system will be supplied in one skid, as indicated in appendix I. The supplier shall include in the tender a general layout drawing with all equipment and discharge ducts.

6.2.2 Equipment

The equipment to be supplied for the Compressed air system are the following:

- Two (2) complete 100% capacity screw compressors (1000 Nm^3/h each, with an operating pressure of 8,5 barg), oil-free, air-cooled and with soundproof enclosure, including a power supply board for each of them
- One (1) complete 200% capacity drying tower (2000 Nm^3/h). The tower will consist of two adsorption drying columns, with regenerative heat, with all piping, valves and other components
- One (1) prefilter, at the compressor discharge, with 200% capacity (2000 Nm^3/h) and automatic trap
- One (1) postfilter, at the drying tower outlet, with 200% capacity (2000 Nm^3/h) and manual trap
- Each filter will include a parallel differential pressure transmitter with local indicator
- Piping and valves (manual and actuated) needed according to the diagram included in appendix A
- Anchor bolts
- Wiring (including cables, conduits and trays) between all pieces of equipment in the scope (motors, towers, instruments, etc.) and power supply and control panels

All pieces of equipment will be mounted in a single rack.

6.2.3 Instrumentation and Control

- All pieces of equipment will be supplied with all instrumentation needed for correct operation, supervision and control of the system
- Local control panel (KKS 00SCA10GH001). For more details, see appendix H of this specification

6.2.4 Paint

Final paint of all compressed air plant components is included, in compliance with the specifications of document 428-00-I-M-27700 and the procedures defined in chapter 10.

6.2.5 Spares and Consumables

The recommended spares and consumables needed for testing and startup of the installation assembly shall be supplied, as well as a list with the spares needed for five (5) years of operation, including prices.

6.2.6 Special Tools for Erection

All special tools needed for equipment erection, as well as for operation and maintenance shall be supplied.

6.3 SERVICES INCLUDED IN THE SCOPE

- Definition of base mats and anchors
- Final paint for all the facility according to specification 428-00-I-M-27700
- Heat insulation, if required
- Preparation for transport
- Transport
- Field erection and commissioning supervision (as an option)
- Submission to the Purchaser/Engineers of all the information, data drawings, curves, procedures, certificates and other documents, as required by this specification and the applicable codes, standards and the reference documents specified herein, including the recommended spare part list for two (2) years of operation
- Field testing and startup.
- Preparation of the specific Project documentation and the documentation needed to obtain the official permits
- One-day training course for operators

6.4 EQUIPMENT AND SERVICES TO BE PROVIDED BY OTHERS

The equipment and services to be provided by others are indicated below:

- Power supply to the power supply panels and the control panel. From these panels, the Supplier shall provide all cables and conduits for supply of the equipment included in the scope of supply and control from the local panel
- Instrument air receiver
- Service air receiver
- Signal wiring between local control panel and DCS
- Civil works

7. SERVICE CONDITIONS

7.1 GENERAL DESCRIPTION

The compressed air system will be able to supply the capacity of compressed air required both by the instrument air network and by the service air network.

The compressors will draw air directly from the environment at the ambient conditions indicated in section 3.2. The compressor discharges will be interconnected, so that the air distribution network storage receivers can be supplied from any of the compressors.

Each compressor will be cooled using air.

Each compressor will be capable of continuous or intermittent operation, charged or discharged, and must operate appropriately in all conditions and in parallel when the air demand requires so.

The compressors will supply compressed air to the service air receiver and to the instrument air receiver, and from these receivers to the following networks:

- Instrument air network

  Compressed air from any compressor will be filtered. Then it will be dried and filtered again to finally be driven to a receiver (supplied by others), from which air is supplied to the instrument network.

- Service air network

  There will be a connection to supply the service air tank at the prefilter outlet, before the drying tower.

  Service air will be supplied to all plant locations from this tank.

7.2 AUXILIARY SERVICES AVAILABLE

The main characteristics of the auxiliary services supplied considered by the Supplier are as follows:

- Power supplies

  For each unit, the Plant will provide a power supply from the Plant to each power supply panel included in the supply, with the following characteristics

  - 400 V ±10% three-phase, 50 Hz (without neutral)

  The Plant will provide two supplies, exclusively for control PLC, from the Plant Ups to the control panel included in the supply, with the following characteristics:

  - 230 V ±10% single-phase, 50 Hz

  The other supplies required will be generated by the Supplier from the above supplies.

8. LIFE CYCLE

8.1 DESIGN LIFE AND AVAILABILITY

CCC Lares is expected to operate at maximum continuous rating as much as possible during all its operating life. However, the plant should be designed to also allow a daily shutdown.

The compressed air system shall be designed and built for a design life of 25 years and a minimum continuous operating life of 215,000 hours (8,000 hours/year).

This requirement is not a guarantee value, but shall be used by the Supplier to determine the wear and ageing of components. This shall be used to establish the maintenance procedures and component replacements required to achieve the 25-year design life (see Section 11.5, Spare Parts).

8.2 MODE OF OPERATION AND LOAD CHANGES

Each unit of the Power Plant shall operate for at least 8000 hours/year at base load. The load operation of each unit shall be independent. The possibility of each unit operating in two (2) shifts, for 16 hours, is anticipated, and, consequently, the necessary startups for annual operation in these conditions shall have to be foreseen.

8.3 COMPONENT RESIDUAL LIFE

Degradation mechanisms such as erosion, corrosion and fatigue caused by vibration, etc. may affect some compressor system components. The Supplier shall consider that no major life extension work shall be required during the design life and therefore those components shall not be designed for repair during the life cycle period. The Supplier shall provide recommendations in the Operating and Maintenance Manuals on improving the residual life of those components, such as limitations on operating modes, process fluid characteristics, lay-up procedures, etc.

The Supplier shall indicate the erosion corrosion allowance, protection measures, special materials, etc included in his supply. As a minimum, a corrosion/erosion allowance of 3 mm shall be used.

The Supplier shall also indicate specific inspection procedures to be followed to monitor the degradation conditions and residual life of these components.

9. DESIGN REQUIREMENTS

9.1 GENERAL

The compressed air system shall be designed in accordance with the codes and standards indicated in chapter 5, as well as with the requirements included in this specification.

The design of the equipment will consider provisions to compensate for the expansion and contraction of the pieces and components, and to counteract all the effects due to the different operating conditions. Thus, the equipment will be designed to receive and withstand all moments and stresses related to startup, normal operation and temperature changes.

In addition, for equipment sizing, it must be taken into account that the drier, during the regeneration process of one tower, demands an air flow which is not included in the design parameters.

9.2 DESIGN PARAMETERS

- Noise level at 1 meter < 82 dB
- Design pressure of the compressed air system 10,3 barg
- Design temperature of the compressed air system 60 ºC

9.2.1 Compressors

- Air pressure at the inlet 1.013 bara
- Air temperature at the inlet from -2.5 ºC to 38.6 ºC
- Design relative humidity 80 %
- Air flow at normal conditions (1)
- Air pressure at the discharge (2)
- Air temperature at the discharge < (14º-17º) above ambient temperature

(1) Needed for a net flow of approx. 1000 Nm^3/h (once the regeneration losses are subtracted).

(2) Needed to achieve 8.5 barg at the receivers (pressure drop at lines between pieces of equipment is nearly zero).

9.2.2 Prefilters

- Oil content of air at the filter outlet — 0.01 ppm (max.)
- Particulate size at the filter outlet — < 10 μm
- Air flow at normal conditions — (3)

(3) Flow of the two compressors working in parallel

9.2.3 Drying Unit (Adsorption Tower)

- Dew point at outlet — -20ºC at 8.5 barg
- Air flow at normal conditions — (4)

(4) The flow of the tower must be able to dry the flow of both compressors working in parallel

9.2.4 Postfilters

- Oil content of air at the filter outlet — 0.01 ppm (max.)
- Particle size at the filter outlet — < 0.5 μm
- Air flow at normal conditions — (5)

(5) Flow of both compressors working in parallel

9.3 DESIGN LOADS

The equipment will be designed to withstand nozzle loads due to thermal expansion, dead loads and ground seismic accelerations. Each piece of equipment subject to simultaneous action of normal operating loads, pressure loads and nozzle loads will be considered.

9.4 OPERATION

The appendix H of this specification includes the detailed description of the operating modes required for compressors and dryer.

9.4.1 Compressors

- Both compressors will be electric-motor operated and designed for continuous or intermittent operation
- Air compressors will be available to work in parallel. At normal conditions, there will be an alternating standby compressor, so that all compressors work approximately the same number of hours
- Each compressor can be started or shutdown, set to load or unload, and selected as main or standby from the equipment panel or from the local control panel. Therefore, each compressor will have a local/remote switch to select the control console
- The compressors will be designed to work in three operating modes:
  - Constant speed with on-load or no-load operation, depending on the discharge pressure
  - Automatic start and shutdown. The compressor will start automatically when the air pressure in the tank or line drops below a given value, and will shut down after reaching maximum pressure in the tank or air line
  - Manual start or shutdown. In case of manual operation, each compressor can be started or shut down regardless of the pressure in the tanks; however, it must have high pressure automatic trip for system protection
- The control provisions for compressors will ensure that:
  - Either compressor can be selected as main compressor (lead)

- The standby compressor (lag) must be able to operate automatically after low pressure signal in the system

- The system global operation will be controlled by the PLC, which will use the pressure value of the receiver pressure transmitter, excluded from the supply, so that:

  > 9 barg: Maximum pressure: plant DCS alarm due to system high pressure (preliminary)

  < 6.5 barg: The standby compressor (lag) changes to operating mode (preliminary)

  < 6 barg: System low pressure alarm at the plant DCS (preliminary)

- Compressors will have a flow/pressure modulated control

- Compressors will start at no-load condition, and the automatic load condition will only occur when the normal operating speed is achieved

- Compressors will be discharged prior to shut down

- Trip of either compressor due to actuation of any of the protection devices described below will prevent a new startup of the compressor until the failure has been corrected

- The actuation of any of the protection devices will trip an alarm in the equipment local panel, in the PLC and in the control room, and will generate a general “anomaly” signal in the corresponding equipment

9.4.2 Drying Tower

- One (1) drying tower will be provided, consisting of two twin towers. Its capacity will be enough to dry to air generated by the two compressors working in parallel at 100%

- It can be started manually or from the control local panel, and they have a local switch to select the required mode, local or remote

- The actuation of any of their protection devices will prevent a new startup of the tower until the failure has been corrected, and an “anomaly” signal will be provided both in the PLC and in the control room

9.5 NOISE REQUIREMENTS

The design and construction of the equipment will ensure that the noise level during operation remains as low as possible.

The noise level of the assembly will not exceed the 82 dBA limit for the sound pressure level on field, measured at one (1) meter from the assembly at any location for any operating mode.

The Supplier shall provide the following information before equipment delivery:

- The Supplier shall include in the Tender a conceptual noise study, justifying the sound level values guaranteed
- The Supplier shall always include in the Tender the noise emission data for the equipment and components included in the specification, and shall fill in the Noise Sheet included in appendix E
- After awarding of the order, the Supplier will send for approval a report and calculations justifying all the noise values guaranteed
- Testing procedures for plant noise measurement. These procedures and guarantees will be in accordance with ANSI/ASME-PTC-36, Measurement of Industrial Sound. In addition, the Supplier shall comply with the requirements indicated in appendix E

9.6 VIBRATION

The Supplier shall include in the Tender a conceptual vibration study justifying the vibration level values guaranteed. The vibration requirements included in appendix E need to be filled.

The vibration levels will comply with the reference standard for evaluation measurement and criteria (ISO), and should not exceed the zone A limits (vibrations for machines on startup). Other operating limits will be indicated for the evaluation zones, as well as the location of alarms and trips.

After award of the order, the Supplier will submit for approval a report and the calculation bases justifying all the guaranteed levels.

Vibrations will be measured in field by the Supplier during the equipment commissioning stage, and according to the procedure sent for approval.

10. CONSTRUCTION REQUIREMENTS

10.1 GENERAL

Manufacturing and its associated inspections will be performed according to the manufacturer's standard. The Tender should indicate the usual checks performed on this type of equipment, at least regarding the following aspects.

10.2 MATERIALS

10.2.1 Equipment

The materials used for manufacturing all the elements comprising the requested equipment will be adequate for the work to be developed, selected with the best quality of their class, must be erosion and corrosion resistant, and all of them must be approved by the Purchaser. In general, a 3 mm thick corrosion margin will be estimated.

Basic materials shall be as follows:

- Compressors:
  - Rotor housing : cast iron
  - Rotor : stainless steel Cr 13%
- Prefilters: stainless steel
- Dryer: the materials used for its construction will be, basically, carbon steel for cylinders and bottoms, and high strength cold-rolled steel for base mats and supports, with the adequate protection according to the Paint Specification. The support for the drying material inside the tower will be stainless steel
- Postfilters: stainless steel

10.2.2 Piping and Valves

In general, the requirements included in the document 428-00-R-M-00410 *Technical Requirements for piping and valves in package plants* will be fulfilled.

10.3 MANUFACTURING

10.3.1 General

In order to start the manufacturing process, the following must be fulfilled:

- The drawings for the component to be manufactured have been completed and approved
- The materials and products to be used have the corresponding legal certificates, and have been accepted for their inclusion in all components of the supply
- The working methods and procedures have been accepted
- The execution personnel has the adequate qualification level and has passed the certification tests for the process requiring them

10.3.2 Compressors

They will have the following characteristics:

- The compressors will be of lubricated screw type, oil-free, with two (2) compression stages and for continuous operation
- They will be air-cooled
- They will have suction valve to improve their performance
- They will have silencer filters to draw air from each compressor, with an efficiency of 99.9% for particles larger or equal to 10 µm, dry-type
- The on-load regulation capacity for each compressor will be 100%
- The outer insulation and protection casing will be calculated to reduce the noise so that, one meter away and one and a half meters high, the level is below 82 dBA
- The compressor will be actuated by a squirrel cage electric motor with space heater. The windings on each stage of the stator will be provided with two three-wire single temperature detectors, type PT100. Bearings will have a three-wire

double temperature detector, type PT100. The motors must be able to start directly with 80% of the rated voltage

- The motor-compressor assembly will be mounted on a single metal base mat
- The compressor design will permit an easy access for inspection and maintenance of all those elements requiring it

10.3.3 Dryer

Prior to instrument air inlet into the tank, drying equipment will be available. The equipment will have one (1) drying tower (consisting of two (2) regenerative columns), capable of treating air generated by the two (2) compressors working in parallel at 100%. In addition, the drying tower will be provided with automatic regeneration through resistors.

They will have the following characteristics:

- Adsorption type and heat regeneration
- The drying columns will have welded construction, according to ASME VIII, div. I requirements
- Each column will have a manhole for inspection, loading and unloading of the drying material without interfering with the pipe, wiring, instrumentation and other equipment elements
- The construction of the support for the drying material will permit an even air flow through the desiccant during normal operation and regeneration
- Their design will permit easy access for inspection and maintenance of all those elements requiring it
- They will have safety valves and manual traps
- Instrumentation needed for the correct operation of the equipment

10.3.4 Filters

- Each filter (be it a prefilter or a postfilter) will have a capacity of 200%, so that each of them can treat air generated by both compressors working at 100%

- The filters will have venting connection, drain connection and easily removable cover
- The prefilter will have an automatic trap and the post-filter a manual trap
- The filtration unit for the prefilter will be replaceable and capable of separating particles and water or oil drops of 10 microns or more without damaging the filtration unit. If will be provided with an automatic blowdown system
- The filtration unit for the postfilter will be replaceable and capable of separating particles of 0.5 micron or more, which could be air borne. It will be provided with a manual blowdown system

10.3.5 Piping, Valves and Connections

In general, the requirements of document 428-00-R-M-00410 *Technical Requirements for piping and valves in package plants* will be fulfilled.

10.3.6 Motors, Power Panels, and Power Cables and Conduits

The electrical equipment will comply with the requirements indicated in the document *Electrical Requirements for Mechanical Equipment and Package Plants*, No. 428-00-R-E-00320.

10.3.7 Instrumentation and Control

Both the instrumentation and the system control must comply with the requirements defined in appendix H to this specification.

10.4 TESTS

All the components will be shop tested by each manufacturer.

Regardless of these tests, whose corresponding protocols and certificates will be attached to the project documentation, the Supplier will perform the following tests:

- Hydrostatic test: pressure test performed according ASME code or PED (the higher pressure) during no less than 30 minutes

- Leaktightness test
- Assembly operating tests
- Noise level tests (see appendix E):
  - The acoustic test procedure will be in accordance with the applicable sections of the reference standard, unless otherwise specified by this specification or the related documents
  - The location and orientation of the microphone will be identical for measurement of the total and ambient noise levels
  - The measurements will be performed 1.5 m high from the ground and 1 m away from the most external surface of any type
  - The microphone will be protected for air currents, vibrations, electric or magnetic fields or any other influence which could affect the readings
  - The measurements will be performed in octave bands. For sound levels from pulsating to cyclical, the maximum sound level read in the counter slow response will be recorded. Unless otherwise specified, the equipment will be tested at full load. If the noise levels with other load conditions exceed the levels for full load, the Supplier should specify it

The requirements indicated in No. 428-00-R-E-00320 document *Electrical Requirements for Mechanical Equipment and Package Plants*, will be taken into account for electrical equipment.

10.5 SURFACE PREPARATION AND PAINTING

10.5.1 General

All equipment parts must be cleaned on shop and/or site, following a procedure which guarantees that they are clean on the inside and on the outside for their transport and painting.

10.5.2 Scope of the Painting Works

The scope of the painting works for the equipment included in this specification is as follows:

The surfaces will be submitted on site with the complete painting system.

The stainless steel surfaces will not be painted.

10.5.3 Preparation of Surfaces and Painting

The preparation of surfaces and coating, as well as their application and technical and inspection requirements, will comply with the Paint Specification 428-00-I-M-27700, which is part of the call for tenders.

The Supplier shall send the completed form that is included as an appendix to the aforementioned specification with the tender documentation.

In addition, the Supplier will send the corresponding Paint Procedure for Purchaser's approval after awarding. If the paint manufacturer is not qualified, the Paint Procedure must include an appendix with the technical data sheets of the proposed paints.

10.6 IDENTIFICATION OF COMPONENTS

The Supplier shall duly identify each component with the sufficient information as to permit its identification during assembly.

Each of the equipment items and components that is sent to the Plant shall be parcelled in the workshop of the manufacturer in such a way that it will be protected against pollutant agents, damage, deformation or loss during its handling and storage. Special attention shall be drawn to the electrical components since they are more sensitive to temperature, moisture, etc.

Each component must be labelled in a legible manner that permits an easy and correct identification.

10.7 INSPECTION POINTS PROGRAMME

10.7.1 General

The Supplier shall submit one (1) Inspection Points Programme for the Purchaser's approval according to the scope of supply. It shall cover reception of materials, manufacture, shop assembly and testing of equipment and documentation submittal.

This Inspection Points Programme shall be submitted to the Purchaser for approval and will explicitly and correlatively detail each of the procurement, manufacturing, testing, painting, cleaning, marking, packing for shipment and site assembly stages, on which the inspection points to be carried out by the Supplier will be indicated.

The applicable internal procedure for each point will be indicated, showing whether a report or protocol will be generated for said point or if there is another document associated with it (quality certificates, reception reports, etc).

The Purchaser shall select the points of this programme they or their representatives wish to witness.

During the inspection visits, the Purchaser reserves the right to review the applicable documentation that has not been submitted to the Purchaser for approval (reception and manufacturing procedures, etc.)

The Inspection Points Programme shall contain, at least, the following sections, indicating in each of them the following information.

10.7.2 Inspection Points Prior to the Manufacturing Process

The inspection points before the manufacturing process shall be the following, as a minimum:

- Review of material and semi-finished products certificates (chemical analysis, heat treatment, mechanical tests) and dimension controls.
- Procedures and examinations of preparation for manufacturing: welding of pressure retaining parts, preparations of weld edges, welder qualifications and non-destructive examinations

10.7.3 Inspection Points during Manufacturing and Assembly

- The inspection points during manufacturing and assembly shall be, as a minimum, the following:
  - Checking of welding procedure plan examinations and records
  - Checking that non-destructive examinations and production tests meet requirements
  - Ultrasonic test of forgings in finished/polishing status
  - Liquid penetrants, magnetic particle or x-ray testing of castings and other products
  - Dimension marking and identification verification (traceability)
  - Checking of heat treatment charts as required
  - Dimensional control according to approved drawing
- Procedures
  - The Supplier shall submit the welding procedures and non-destructive examinations to be used for equipment manufacture, for Purchaser's approval
  - Welding procedures, as well as the welders who shall participate, shall be qualified, in compliance with ASME Code, Section IX
  - The Supplier shall be provided with an adequate maintenance system for welding filler materials, ensuring lack of humidity in coated and flux-electrodes by means of central heaters, portable heaters, etc.

10.7.4 Inspection Points after Manufacturing

The inspection points after manufacturing shall include, as a minimum, the following:

- Hydraulic pressure test
- Leaktightness test (if applicable)
- Functional tests
- Examination of cleaning before coating, and coating materials

- Examination of coating (painting)
- Checking of nameplates
- Checking of CE marking
- Visual inspection
- Revision of the final documentation
- Checking preparation for transportation and packing
- Shipment authorisation

10.8 INSPECTION OF WELDS

Welds will be inspected for all pipes using radiography and/or liquid penetrant test, if applicable.

For lines with 2” diameter or less, the acceptance criteria are those required in code B31.1, section 136.4.

10.9 VERIFICATION BEFORE RELEASE FOR TRANSPORTATION

- Checking the marking of all parts according to the approved material list including spares and special tools
- Checking non-conformance reports and repairs carried out
- Examination of project documents (design and manufacture) including changes and approved non-conformance
- Checking shopping preparations including packing

10.10 MATERIAL, EQUIPMENT AND AUXILIARY ITEMS INSPECTION

The inspection shall include the verification of chemical analysis, mechanical tests, certificates of origin, non-destructive exams, tests protocols, etc, as indicated further on, in compliance with this Technical Specification and with the Codes and Standards specified in Section 5.

The Supplier shall own a suitable maintenance system for welding materials, making sure of the absence of moisture in the coated electrodes, using central heaters, portable heaters, etc.

11. MAINTENANCE REQUIREMENTS

11.1 MAINTENANCE PROGRAMME

The Supplier shall provide an equipment maintenance programme including the list of inspection and maintenance tasks to be performed during the design life. The maintenance programme shall include the list of components replaced and the frequency and duration of the maintenance tasks.

The Supplier shall describe his maintenance service capabilities as well as his availability to supply spare parts and replacement components during operation on the Purchaser's request, based on his logistic capacity.

The Supplier shall provide the air compressor equipment Operating and Maintenance Manual(s) which shall contain detailed information for inspection and maintenance of the equipment and its auxiliaries. This manual shall include recommended procedures for scheduling inspections and maintenance outages, descriptions of the tests to be performed, tools and equipment needed, disassembly practices, component inspection, reassembly, etc. The manual shall include all necessary drawings, lists, data sheets, bills of materials, etc. required for performing the tasks and ordering the materials.

In case of repairs or special maintenance tasks that may require the removal of the component from its location, the Supplier shall recommend the location to perform the work, eg site workshop, Supplier's facilities, etc.

The above information, provided by the Supplier, will allow the Purchaser to develop the complete maintenance programme for the overall plant.

11.2 PRECAUTIONS AND LIMITATIONS

The Operating and Maintenance Manual(s), operating instructions, inspection procedures and other documentation related with maintenance and operation, including the procedures for the equipment erection and testing, shall include written precautions and limitations, in cases where use of said documents could cause severe injury to, or the death of, the operating and maintenance personnel, or serious damage to the environment and/or to the equipment.

The precautions, warnings and cautions shall alert the document users to action and/or conditions that represent potential hazards to personnel (electric shocks,

hazardous substances, risk of falling, etc.), the environment, or possible damage to equipment (handling equipment, fire hazards, incorrect operation, etc.). Limitations shall define the boundaries that are not to be exceeded. Documents (manuals, procedures etc.) shall include written precautions, warnings and cautions on all individual action steps that may originate hazardous conditions.

11.3 ACCESS AND HANDLING REQUIREMENTS

The Supplier shall consider, in the design of the compressors and auxiliaries, the access required to perform the maintenance inspections operations defined in the corresponding manuals.

If required, the Supplier shall indicate the component maintenance handling tools and equipment necessary for all items that require special handling. The Supplier shall define the handling of equipment such as water boxes, tubes, etc., indicating weights, sling locations, balance points, methods of attachment and other pertinent features to be considered for safe handling.

11.4 SPECIAL TOOLS

If required, the Supplier shall provide a list identifying any special tools required for operation and maintenance of the air compressor equipment and auxiliaries in accordance with the Operating and Maintenance Manual(s).

If required, the Supplier shall identify and indicate the cost of the special tools required for the erection (by third parties) of the equipment and auxiliaries, and those which may be used for operation and maintenance.

All tools finally agreed to be supplied under the contract shall be referenced as regards their use on application in the Operating and Maintenance Manual(s).

11.5 SPARE PARTS

The Supplier shall include, in his supply, the recommended spares and required consumables for testing equipment, plant start-up and commissioning. The proposal shall include a detailed list of such spares and consumables, which will indicate, at least, the number of units (or volume), replacement frequency, necessary time for its replacement, and unit price. Recommended spares and consumables shall be consistent with the Operating and Maintenance Manual(s). The specific replacement instructions shall be included in the O&M Manual(s).

The Supplier shall be responsible for the prompt spares replacement required during testing, commissioning and start-up phases, with no significant incidents. To this end, the Supplier shall ensure that these spares and consumables stocks are available, and shall provide them as quickly as possible at the price referenced on the list included in the proposal.

Spares shall be sent to the site, duly marked and packed for protection against damage, deformation, loss, etc, during their transport, handling and storage. The Supplier shall state the storage requirements applicable to the spares, if any.

The Supplier shall include in the proposal a list of recommended spares for an operating period of five (5) years for the supplied equipment and instruments. This list shall provide spare identification, identification of the equipment to which it pertains, unit price estimated, frequency of consumption and delivery time. The Supplier shall guarantee these recommended spares availability for the design life established for the power plant, and advising with sufficient advance if he cannot maintain this commitment.

The spare parts and consumables supplied and the recommended spare parts included inside the list shall be consistent with the Maintenance and Operation Manual Instructions.

11.6 TEST EQUIPMENT AND SERVICES

The Supplier shall furnish all non-permanent instruments or equipment required for performing tests and the final acceptance tests of the compressors and auxiliaries. These testing instruments shall be removed after the acceptance test and returned to the Supplier. If the performance test requires specific testing software or computer applications, they shall be delivered to the Purchaser to ensure test repeatability.

All testing instruments or equipment shall be qualified and calibrated in accordance with the applicable standards.

12. PROJECT AND DOCUMENTATION CONTROL

12.1 PROJECT CONTROL

The Supplier shall submit monthly project reports. Deviation from the project schedule shall be identified. An activities plan for the next period and an action plan to avoid deviations and to eliminate pending items shall be included in the report. The monthly report must be brief and concise.

A kick-off meeting between the Supplier and the Purchaser will be held within 10 days subsequent to the date of acceptance of the Purchase Order. Authorised representatives shall attend this meeting to resolve any technical, scheduling and contractual issues.

Meetings (one per month if necessary) at the Supplier's facilities will be held to ascertain the project quality and progress. Development of the design, material take-off, fabrication, subcontractors works, tests, etc. will be analysed during these meetings. The dates and place of these meetings shall be reflected in the contractual project schedule; however, the Purchaser reserves the right to hold additional meetings with due advance.

12.2 DOCUMENTATION REQUIREMENTS

Documents, drawings and data shall be furnished in accordance with the attachment *Matrix of Required Documents* to be found in Appendix D. The documents related to the electrical motor shall be in accordance with the document *Electrical Requirements for Mechanical Equipment and Package Plants* No. 428-00-R-E-00320.

The project documentation support shall be in accordance with that established in the bid request.

All documents shall include at least the own supplier identification, the KKS identification of the documents, the project identification number, date and number of issue, status changes control table, applicable or reference documents, author and supervisor signatures.

Documents shall be written in English. Units shall be in accordance with the International System of Units.

Documents shall be developed in or be compatible with MS Office. Drawings shall be delivered in AutoCAD format or electronic version (.dwg or .dxf formats).

12.3 DOCUMENTS TO BE SUPPLIED WITH THE PROPOSAL

The proposal submitted by the prospective Supplier shall include in the technical part, a detailed description of the equipment offered. The Supplier shall provide all the data called for in the Technical Proposal Data Sheets, Appendix B to the specification.

The Data Sheets are provided on paper and on electronic support to facilitate their use by the prospective Supplier.

The Bidder shall fill in the values and information required in the data sheet to enable the Purchaser to carry out an appropriate evaluation of the equipment items tendered. No other format will be accepted. The use of the document format on electronic support is recommended.

The Proposal should include, but not be limited to, the following information:

- General description of the compressed air system, including diagrams describing the flow of the process
- Technical datasheets, including the main components (compressors, dryers, filters, valves, etc)
- General layout drawings, with indications of dimensions and parts, including geometrical definition of the pipes and compressed air system components
- List of components of the compressed air system (valves, pipes, filters, purgers, instrumentation)
- Technical requirements for the services provided by others (electric power supply, water, etc) if applicable
- Noise level
- Recommended list of spares, special tools and testing equipment, according to requirements of section 11 of this specification and for startup and commissioning
- Part drawings for transport and field erection, if applicable

- Project documents
- Preliminary inspection point programme
- List of compressed air systems of similar size and operation that have been designed and built by the Supplier, including the year of commissioning
- List of exceptions
- For the electrical equipment document, see document *Electrical Requirements for Mechanical Equipment and Package Plant* No. 428-00-R-E-00320.

Special attention must be paid to the values and requirements specified in the data sheets and marked with an asterisk, as they constitute mandatory requirements, unless explicitly indicated otherwise. The same requirements and values, if indicated on the data sheets without an asterisk, constitute recommendations from the Purchaser that the prospective Supplier may accept or to which he may propose alternatives.

The Compressed Air Equipment Proposal shall include all information listed in Appendix D “Matrix of Required Documents” marked in the column “proposal”

In addition, the Bidder shall include at the *beginning* of the technical portion of his proposal *one* of the following two statements, exactly as detailed below, entering the project title and technical specification number and issue, as detailed on the front cover of this specification:

PROJECT:

The equipment offered in this proposal is in full conformity with the requirements of Technical Specification No. ....., Issue ..... .

PROJECT:

Apart from the variations and exceptions noted and specifically listed in a separate section which forms part of this proposal, the equipment offered in this proposal is in full conformity with the requirements of Technical Specification No. ....., Issue ..... .

12.4 PROJECT DOCUMENTS TO BE SUPPLIED FOR INFORMATION OR APPROVAL

The generic technical documents shall be submitted by the Supplier for Purchaser information or approval in accordance with the contract. These documents shall include all information needed for project interfaces, input data for plant detail design and construction, contract follow-up and for equipment maintenance and operation. The date for the submission of each document is also indicated.

The Supplier will provide the Verification Plan and complete specific project document list after acceptance of the Purchaser Order. This document shall be commented at the kick-off meeting for Purchase approval. The list will identify all documents to be developed by the Supplier for this project, indicating those to be classified for information or approval, and the submittal date of each document.

The Purchaser will comment on the list of project documents, marking those that shall be submitted for his approval or those that contain input or interface data required for the development of the overall project. The submittal date will also be commented and agreed upon between the Supplier and the Purchaser at the kick-off meeting.

The Supplier is not to proceed with the fabrication beyond the point where changes in orientation would necessitate reworking prior to receipt of Purchaser approval. Documents submitted to the Purchaser “for Approved” will be marked, signed and returned. Those marked “Approved excepting notes” or “Disapproved” must be corrected by the Supplier and returned to the Purchaser within 10 working days.

The following information has been considered to be in the critical path for the Purchaser and should be considered by the Supplier as top priority and be submitted at the earliest date after the kick-off meeting and not later than the time stipulated below. The documents related to electrical motors shall be in accordance with document, *Electrical Requirements for Mechanical Equipment and Package Plants*, 428-00-R-E-00320.

Document	Submittal date
List of project documents	Kick-off meeting
Verification Plan	Kick-off meeting
Design, fabrication, erection and testing schedule.....	2 weeks
Technical documentation of the components.....	2 weeks

Document	Submittal date
Flow and instrumentation diagrams	2 weeks
Dimension outline and general arrangement drawings.....	4 weeks
Noise level calculation of the compressed air system	2 weeks
Electric circuit schedule.....	6 weeks
Inspection point programme.....	2 weeks
Welding procedures	8 weeks
Non-destructive test procedures	8 weeks
Coating, packing and shipment procedures	4 weeks
Testing procedures	4 weeks
List of materials and components	4 weeks
Operating and Maintenance Instruction Manuals.....	16 weeks
List of recommended spare parts.....	4 weeks
List of special tools and test equipment	4 weeks
For I&C documentation, see Appendix H, Documentation for official projects	8 weeks
For electrical equipment documentation, see document *Electrical Requirements for Mechanical Equipment and Package Plants*	See document 428-00-R-E-00320

The purpose of this timetable is to close the interfaces and the basic equipment documentation within 8 weeks from the kick-off meeting.

12.5 FINAL DOCUMENTATION

Any changes to the documents shall be controlled during the development of the project. Changes may originate from design modifications, nonconformity, as-built deviation, etc. All changes approved by the Purchaser shall be incorporated in order to maintain all project documents updated. The final issue (as built) of all documents shall be incorporated into a Final Dossier. The Final Dossier shall be sent to the Purchaser after the final approval documents, as indicated below.

12.5.1 Engineering File

On completion of Manufacturing, the Purchaser shall send the Supplier an Engineering File that contains, but is not limited to, the following documents:

- Technical data sheets (compressors, motors, dryers and filters) and starting and performance curves of the motors
- P&ID of all the Compressed Air plant, control schedules and wiring diagrams of all the components
- Electric drawings of equipment of the Air Plant
- Pneumatic drawing of the dryers
- List of electrical consumers
- List of instruments included in the plant
- List of valves used in the system
- List of the limits of the scope
- Arrangement and dimension drawings of the equipment
- Constructive drawings for compressors, dryers and filters
- Mechanical calculation for the compressors, dryers and filters
- Piping drawings
- Storage and maintenance in the plant instructions before commissioning
- Erection, maintenance and operating instructions

12.5.2 Quality Dossier or Manufacturing File

On completion of the supply, the Supplier shall provide a final manufacturing file, including the final issue of the documents included in the list of project documents, that, as a minimum, contains the following documents:

- Copy of Official Certification of the Supplier's Quality System, if it exists

- Copy of the Certificates of compliance with EC directives
- Inspection points Programmes completed. This document, with all the points duly signed and stamped by the Supplier and with the Purchaser's signature and stamp at the points he has witnessed, will be sufficient as record of inspection activities
- Copy of the procedures submitted for approval (coating, welding, tests)
- Copy of quality certificates, reception reports, test reports, test protocols, etc, indicated in the Programme as to be issued at each point
- Inspection reports of all the equipment
- Documented reports on significant deviations that have occurred, if any
- Copy of Shipping Authorisation
- Manufacturer's Final Quality Certificate

12.5.3 Maintenance and Instruction Manuals

The Maintenance and Instructions manuals shall be written in Portuguese.

This document shall contain all the information required for the operation and maintenance of equipment during the operation phase, as well as all the procedures required to carry out any necessary repairs during the lifetime of the equipment.

These documents shall be sent completely fastened together and bound.

Manuals shall include, but not be limited to, the following:

- Equipment storage requirements
- Installation, startup and initial test instructions
- Operating instructions, including but not limited to safety precautions and operating limits
- Maintenance procedures, routine adjustments, preventive maintenance schedules and any predictive maintenance recommendations

- Parts illustrations, including parts lists adequate for the purpose of identifying and ordering replacement parts and designation of the number required per component and lists of recommended spare parts
- Detailed descriptions of the functions of each principal component of a system
- Safety precautions

All post-award documents required in the matrix of required documents (Appendix D) which follows shall be included.

The Supplier shall submit five (5) copies plus one in electronic format of the manuals.

12.5.4 Final Dossier

The Final Dossier is made up of the following documents, which were indicated previously:

- Engineering File
- Quality Dossier
- Maintenance and Instructions Manual

The Final Dossier shall be completely fastened together and bound. The Supplier shall submit five (5) copies plus one in electronic format of the Final Dossier.

13. QUALITY ASSURANCE

The Supplier shall have a documented and implemented Quality Assurance System. As a minimum requirement, this system shall contain written procedures to ensure that adequate control of manufacturing, installation, testing and inspection is established to meet the requirements of this specification. This system shall include means for control of materials, parts and components, a plan for inspection of manufacturing operations, document control, control for special processes (eg heat treating, welding, non-destructive testing, qualified welding procedures and data forms) and procedures for final tests and inspections. The Supplier shall also apply similar quality control requirements to his subcontractors and suppliers. The Quality Assurance Manual shall be available to the Purchaser and his authorised representative upon request.

The Purchaser may perform factory quality assurance inspections at the Supplier's facility during fabrication to ensure equipment is being built to the specification in a timely manner.

As a part of, or prior to that inspection, the Purchaser shall review the Supplier's Quality Assurance and Quality Control System and manuals to assure their adequacy for equipment being supplied. Quality Assurance audit may be performed by the Purchaser during the inspection, to verify that the Supplier's Quality Assurance System is being adhered to.

The Supplier shall submit for Purchaser approval the disposition of nonconforming material discovered during final inspection and test or at any time within the warranty period. It shall be the responsibility of the Supplier to make a disposition of materials identified as nonconforming with this specification satisfactory to the Purchaser. The Supplier shall at its own expense repair or replace defective or unsatisfactory materials at the Supplier's shop or project site depending upon where the defect is noted.

14. VERIFICATION OF REQUIREMENTS

14.1 CRITERIA FOR VERIFICATION OF REQUIREMENTS

The Supplier is responsible for the verification of all requirements defined in the product specification and applicable codes and standards. The method of verification, dates, places and personnel as well as acceptance criteria shall be proposed by the Supplier and approved by the Purchaser. The method finally selected, in accordance with the above conditions, will be chosen from among the following depending on the project phase.

Project Phase	Verification Method
• Design and engineering	• Design review meeting and document review
• Equipment manufacturing at Supplier's facilities (including subcontractors)	• Examination and inspection before processing • Inspection and testing during manufacturing process
• Site assembly and tests (by others, supervised by Supplier)	• Inspection and test on site
• Final acceptance (by others supervised by Supplier)	• Performance test on site

Nothing in this specification shall relieve the Supplier of the responsibility of performing, in addition to the requirements of this specification, such analyses, tests, inspections and other activities which may be considered necessary to ensure that the design, materials and workmanship are satisfactory for the service intended, or as may be required by common usage or good practice.

The Supplier shall prepare a Verification Plan including the different verification methods considered distributed over the period from contracting to acceptance of the goods and services. The Verification Plan shall contain as a minimum the list of documents to be submitted for approval and the inspection points programmes.

Comments shall be made to the Verification Plan for the Compressed Air equipment and it shall be approved by the Purchaser during the kick-off meeting. The Verification Plan ends with the product and services acceptance test.

The review or approval by the Purchaser of the Supplier's drawings, procedures, design details, data, calculations, analyses, specifications, etc. does not constitute acceptance of any designs, materials, procedures, calculations, etc., which will not fulfil the requirements established in this specification and all referenced specifications, codes and standards. Performance of any work and/or fabrication of equipment prior to obtaining the Purchaser's approval is at the Supplier's risk.

The following paragraphs contain the requirements that the Supplier shall consider in the preparation of the Verification Plan and of related documents and services.

14.2 DESIGN AND ENGINEERING PHASE

Where the product specification refers to design requirements, the Purchaser shall incorporate the proposed solution into the project plant design documentation. The document review and/or engineering review meetings are the most common way to verify for design requirements. Where other methods, or a combination of methods of design verification are used (eg, inspection or testing) this shall be indicated accordingly.

Project documents prepared by the Supplier which show design requirements shall be identified by the Supplier and included in the project documents list so as to be reviewed by the Purchaser. In addition, the Purchaser will comment on and approve other documents including interface information. The review process may be facilitated and completed at a Design Review meeting where design solution and documents should be approved.

During this phase the Supplier (and Subcontractor as applicable) Quality Plan shall be approved by the Purchaser. If additional measures are to be taken, these shall be taken by the Supplier during the approval documentation phase.

14.3 MANUFACTURING EXAMINATIONS AND TESTS

There are requirements to be verified during the procurement of materials, and manufacturing process of the Compressed Air equipment and auxiliaries either at the Supplier's facilities or the Supplier's Subcontractor's facilities. The Supplier shall define, in accordance with section 10.7, Inspection Points Programme, the manufacture inspection programmes to be submitted to the Purchaser for approval (project document list).

In addition to the Manufacturing Inspection Points Programme, the Purchaser has the right to carry out verifications at the Supplier's facilities whenever considered convenient.

14.4 SITE ASSEMBLY EXAMINATIONS AND TESTS

The Supplier is responsible for the verification of requirements during the erection and testing of the equipment and auxiliaries which is to be performed by others. The Supplier shall establish adequate supervision and review of the erection and site testing. In addition, the Purchaser has the right to carry out verification whenever considered convenient. The following verification defined by the Purchaser is to be applied to the Compressed Air equipment and auxiliaries during this project phase:

- Verification points defined in the Supplier's site assembly inspection points programme
- Erection procedures, including handling and assembly of parts
- Applicable examination and testing concerning manufacture process performed on site
- Final cleaning and coating
- Site hydrostatic test and leak test as required, if required

14.5 ACCEPTANCE TEST

Acceptance tests are described in section 10.4.

The noise level guaranteed must not exceed 82 dB(A) at 1 meter from the compressor.

Equipment protection and the repair of any defect or fault detected during the tests will be the Supplier's responsibility, as well as the repetition of the tests until the design conditions are met.

15. GUARANTEES

The Supplier shall guarantee that all pieces of equipment in his scope of supply comply with all the requirements defined in this specification. The compressed air system will be flawless as regards its design, materials, manufacturing or field erection, and will work during Plant operation according to the specified performance.

The components and items replaced by the Supplier including the repair work, during the applicable guarantee period, shall have the same guarantee period as the original components.

The following compressed air system performances shall be guaranteed up to December 31, 2011.

The compressed air system will be able to guarantee the following values:

- The system will be adequate for the service described in this specification
- The instrument air quality will comply with ANSI/ISA-57.3-1975
- The instrument air production will comply with ANSI/ISA-RP 7.7-1984
- The equipment will comply with the operating and design conditions indicated in this specification
- Noise level below 82 dBA at 1 meter from the compressor and at an elevation of 1.5 m from it
- Dew point of -20º C or below at operating conditions

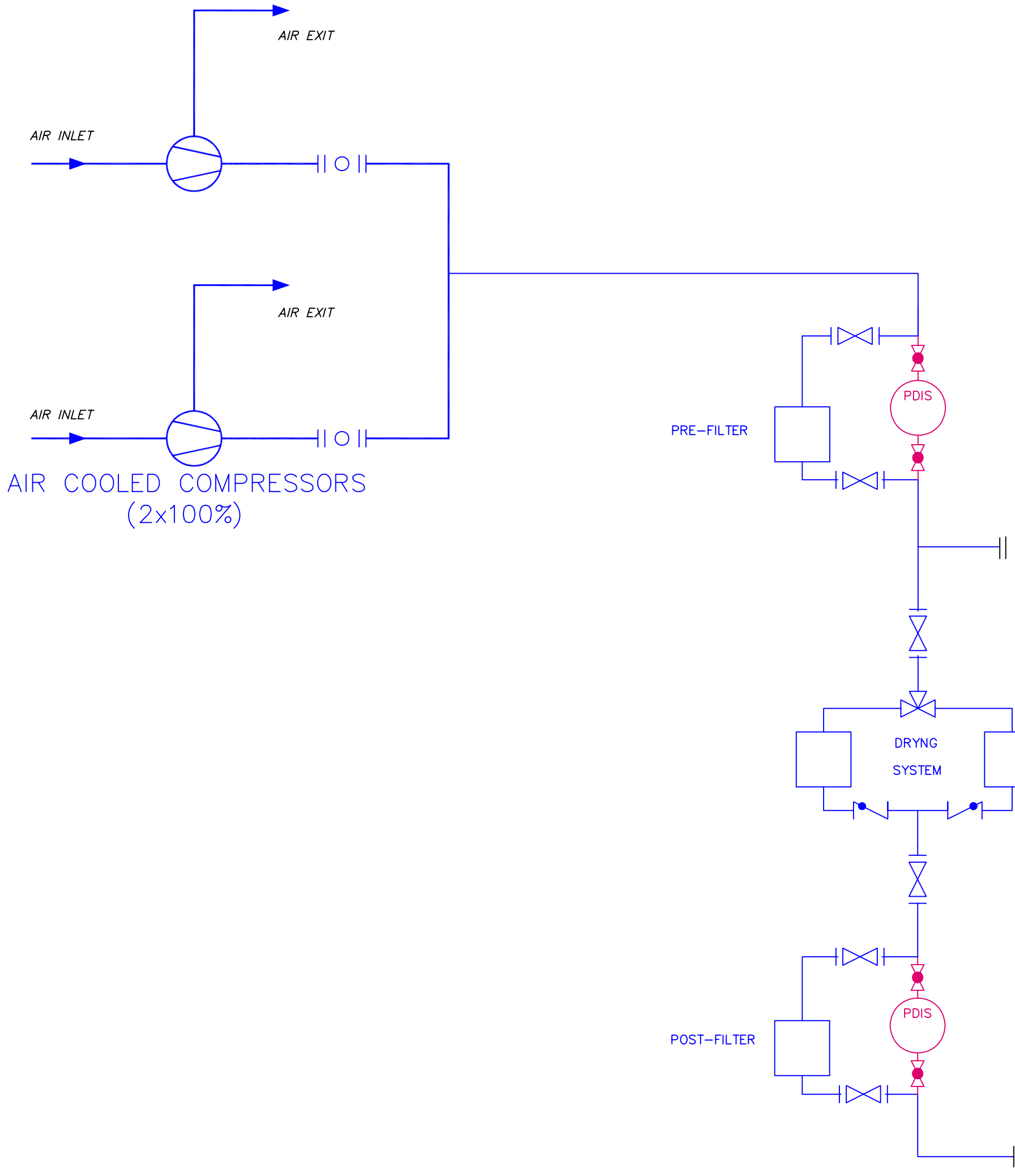
The Purchaser will penalize the Supplier if the guaranteed levels are not reached during tests, or will reject the Supply (in part or as a whole) if the faults are not corrected in a short period of time.

The Supplier shall guarantee the integrity of the Compressed Air System for the following included in document General Purchasing Condition, extending from the start of the Final Acceptance.

In the event that defects appear during the guarantee period, the Supplier shall correct any failures in the shor test period of time possible.

APPENDIX A

FLOW CHART OF THE COMPRESSED AIR SYSTEM


AIR EXIT
AIR INLET
AIR EXIT
AIR INLET
AIR COOLED COMPRESSORS
(2x100%)
PRE–FILTER
PDIS
DRYNG
SYSTEM
POST–FILTER
PDIS

APPENDIX B

COMPRESSED AIR EQUIPMENT DATASHEETS

EMPRESARIOS AGRUPADOS	PROJECT: CENTRAL DE CICLO COMBINADO DE LARES COMPRESSED AIR EQUIPMENT DATA SHEET	DOC. n.: HD-00SCA10/20AN001 SHEET n.: REV. / BY / DATE: 1 / AFF / 11/09/2007

1	**GENERAL**		
1.1	**AMBIENT CONDITIONS**		
1.1.1	Maximum and minimum temperature	ºC	40 -2,5
1.1.2	Pressure	bara	1,013
1.1.3	Design relative humidity	%	80
1.1.4	Height above sea level	m	7
1.1.5	Supply voltage	V/ph/Hz	400/3/50
2	**COMPRESSORS**		
2.1	**GENERAL**		
2.1.1	ITEM Nº (KKS)		00SCA10/20AN001
2.1.2	Nº compressors		2
2.1.3	Location		☑ Inside ☐ Outside
2.1.4	Compressor type		Screw, oil free
2.1.5	Manufacturer		*
2.1.6	Model		*
2.2	**OPERATING CONDITIONS**		
2.2.1	Operating pressure (**N1**)	barg	*
2.2.2	Maximum operating pressure	barg	10,3
2.2.3	Minimum operating pressure	barg	6
2.2.4	Net air capacity (**N2**)	Nm^3/h	1000
2.2.5	Compressed air outlet temperature (**N3**)	ºC	*
2.2.6	Sound pressure level (< 82 dBA)	dBA	
2.2.7	Male rotor speed 1st stage	rpm	
2.2.8	Male rotor speed 2nd stage	rpm	
2.3	**DRIVE MOTOR**		
2.3.1	Manufacturer		*
2.3.2	Model		*
2.3.3	Nominal Output	kW	
2.3.4	Efficiency	%	
2.3.5	Rated speed	rpm	
2.3.6	Supply voltage	V	400
2.3.7	Minimum startup voltage	V	
2.3.8	Rated current	A	
2.3.9	Startup current (**N4**)	A	
2.3.10	Heating resistor capacity ☑ YES ☐ NO	kW	
2.3.11	Rotor type		☑ Squirrel cage ☐ Winding
2.3.12	Pt-100 RTD in windings (**N5**)		☑ YES ☐ NO

2.4	**COOLING SYSTEM (WATER)** ☐			**COOLING SYSTEM (AIR)** ☑	
2.4.1	Cooling water through ☐ Tubes ☐ Shell			Cooling air flow (m3/h)	
2.4.2	Intercooler material			Vent air temperature at the compressor outlet (ºC)	
2.4.3	Water pressure drop (bar)			Heat extracted by the cooling fans (kW)	
2.4.4	Cooling water flow (m3/h)			Minimum volume of the room that will house the equipment (m3)	
2.4.5	Design Pressure (barg)			Number of cooling fans	
2.4.6	Heat load transferred to the water (kJ/h)			Cooling fan motor power (kW)	
2.4.7	Cold temperature difference (C.T.D.) (ºC)			Fan discharge pressure (bar)	
2.4.8				Pressure loss in the fans (bar)	
2.4.9				Fan motor efficiency (%)	
2.4.10				Air exhaust duct dimensions (mm x mm)	

2.5	**OIL CIRCUIT**		
2.5.1	Oil pump power	kW	
2.5.2	Pump performance	%	
2.6	**CONSTRUCTION DATA**		
2.6.1	Height	mm	
2.6.2	Width	mm	

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2.6.3	Length		mm			
2.6.4	Total weight		kg			
2.6.5	CONNECTION FLANGES (**N6**)	DIAMETER (mm)	RATING	FLANGE TYPE		FACE TYPE
2.6.6	Air compressors outlet			☐ WN ☐ SOW ☐ SW		☐ FF ☐ RF
2.6.7	Condensate drain outlet			☐ WN ☐ SOW ☐ SW		☐ FF ☐ RF
3	**PREFILTERS**					
3.1	**GENERAL**					
3.1.1	ITEM Nº (KKS)		00SCA10AT001			
3.1.2	Manufacturer					
3.1.3	Nº Filters		1			
3.1.4	Filter type					
3.1.5	Model					
3.2	**DESIGN CONDITIONS**					
3.2.1	Design Pressure		barg	10.3		
3.2.2	Design Temperature		ºC	60		
3.2.3	Capacity of each filter (**N7**)		Nm^3/h	2000		
3.2.4	Particle size at outlet (water & oil)		μm	10		
3.2	**CONSTRUCTION DATA**					
3.2.1	Weight		kg			
3.2.2	Volume		m^3			
3.2.3	CONNECTION FLANGES (**N6**)	DIAMETER (mm)	RATING	FLANGE TYPE		FACE TYPE
3.2.4	Inlet flange			☐ WN ☐ SOW ☐ SW		☐ FF ☐ RF
3.2.5	Outlet flange			☐ WN ☐ SOW ☐ SW		☐ FF ☐ RF
3.2.6	Construction material (ASTM)					
3.2.7	Design code					
4	**DRYER UNITS**					
4.1	**GENERAL**					
4.1.1	ITEM Nº (KKS)		00SCA10AH001			
4.1.2	Nº units		1			
4.1.3	Nº columns per unit		2			
4.1.4	Manufacturer					
4.1.5	Model					
4.1.6	Regeneration type		☐ With heat ☐ Without heat			
4.2	**DRYER COLUMNS**					
4.2.1	Design Pressure		barg	10,3		
4.2.2	Operating pressure		barg	8,5		
4.2.3	Design Temperature		ºC	60		
4.2.4	Operating temperature		ºC			
4.2.5	Test pressure		bar	15		
4.2.6	Inlet flow		Nm^3/h	2000		
4.2.7	Power rating, resistors		kW			
4.2.8	Drying/Regeneration cycle times		h/h			
4.2.9	Dry air flow for regeneration for each unit		Nm^3/h			
4.2.10	Load loss per unit		bar			
4.2.11	Dew point at operating pressure		ºC			
4.3	**CONSTRUCTION DATA**					
4.3.1	Column volume		m^3			
4.3.2	Weight per dryer unit		kg			
4.3.3	CONNECTION FLANGES (**N6**)	DIAMETER (mm)	RATING	FLANGE TYPE		FACE TYPE
4.3.4	Inlet flange			☐ WN ☐ SOW ☐ SW		☐ FF ☐ RF
4.3.5	Outlet flange			☐ WN ☐ SOW ☐ SW		☐ FF ☐ RF
4.3.6	Desiccant type					
4.3.7	Construction material (ASTM)					
4.3.8	Design code					

EMPRESARIOS AGRUPADOS	PROJECT: CENTRAL DE CICLO COMBINADO DE LARES COMPRESSED AIR EQUIPMENT DATA SHEET	DOC. n.: HD-00SCA10/20AN001 SHEET n.: REV. 1 / BY AFF / DATE 11/09/2007

5	**POST-FILTERS**					
5.1	**GENERAL**					
5.1.1	ITEM Nº (KKS)			00SCA10AT002		
5.1.2	Manufacturer					
5.1.3	Nº Filters			1		
5.1.4	Filter type					
5.1.5	Model					
5.2	**DESIGN CONDITIONS**					
5.2.1	Design Pressure		barg	10,3		
5.2.2	Design Temperature		ºC	60		
5.2.3	Capacity of each filter (**N7**)		Nm^3/h	2000		
5.2.4	Particle size at outlet (water & oil)		µm	<0.5		
5.3	**CONSTRUCTION DATA**					
5.3.1	Weight		kg			
5.3.2	Volume		m^3			
5.3.3	CONNECTION FLANGES (**N6**)	DIAMETER (mm)	RATING	FLANGE TYPE		FACE TYPE
5.3.4	Inlet flange			☐ WN ☐ SOW ☐ SW		☐ FF ☐ RF
5.3.5	Outlet flange			☐ WN ☐ SOW ☐ SW		☐ FF ☐ RF
5.3.6	Construction material (ASTM)					
5.3.7	Design code					
6	**DRUMS (RECEIVERS)**					
6.1	**GENERAL**					
6.1.1	ITEM Nº (KKS) N/A					
6.1.2	Nº receivers					
6.1.3	Manufacturer					
6.2	**DESIGN CONDITIONS**					
6.2.1	Design Pressure		barg			
6.2.2	Test pressure		barg			
6.2.3	Capacity		m^3			
6.3	**CONSTRUCTION DATA**					
6.3.1	Height		mm			
6.3.2	Diameter		mm			
6.3.3	Weight		kg			
6.3.4	CONNECTION FLANGES (**N6**)	DIAMETER (mm)	RATING	FLANGE TYPE		FACE TYPE
6.3.5	Inlet flange			☐ WN ☐ SOW ☐ SW		☐ FF ☐ RF
6.3.6	Outlet flange			☐ WN ☐ SOW ☐ SW		☐ FF ☐ RF
6.3.7	Construction material (ASTM)					
6.3.8	Design code					

7	**NOTES**	
	N1	That needed to achieve 8.5 barg in the instrument air receiver
	N2	Minimum flow produced by each condenser minus the dry air needed for the regeneration of the tower
	N3	Not to be higher than ambient temperature plus 14ºC
	N4	Cannot be more than 3 times rated current
	N5	One double Pt-100 RTDs will also be included in each bearing, to heat detection. The Pt-100 RTDs will be 3-wire.
	N6	That defined in Appendix C to the Specification will apply to the connection flanges.
	N7	Each filter will be 200% capacity, in other words, each of them will be able to filter the flow of the compressors working in parallel
	N8	They will have appropriate surface protection according to the Painting Specification

APPENDIX C

PIPE-VALVE REQUIREMENTS

See document 428-00-R-M-00410 Technical Requirements for Piping and valves in package plants.

APPENDIX D

MATRIX OF REQUIRED DOCUMENTS

DOCUMENTATION TO BE SUBMITTED BY THE SUPPLIER					
ITEM	PROJECT DOCUMENTATION	DELIVERY PLAN (Weeks after purchase order)			NOTES
		INFORMATION REQUIRED WITH TENDER	DOCUMENTATION FOR COMMENTS AND APPROVAL	DOCUMENTATION FOR INFORMATION AND RECORD	
1	**ADMINISTRATIVE DOCUMENTS**				
1.1	Manufacturing plan	Preliminary	RL , 2 weeks		Comments RL
1.2	Monthly reports			*	
1.3	List of subcontractors	Preliminary		RL, 2 weeks	Comments RL
1.4	List of spares	Preliminary		RL, 4 weeks	Comments RL
1.5	List of project documents	Preliminary		RL, 2 weeks	Comments RL
1.6	Design information	Preliminary		*	
1.7	List of exceptions and clarifications	Preliminary		*	Comments RL
2.	**ENGINEERING DOCUMENTS**				
2.1	MECHANICAL DOCUMENTS				
2.1.1	P&ID	Preliminary	RL, 2 weeks		Comments RL
2.1.2	Completed data sheets	Preliminary	RL, 2 weeks		Comments RL
2.1.3	Dimensional drawings, including weights	Preliminary	RL, 4 weeks		Comments RL
2.1.4	Detail drawings		4 weeks		
2.1.5	Piping layout (Isometrics)	Preliminary	RL, 4 weeks		Comments RL
2.1.6	Mechanical terminal points	Preliminary	RL, 2 weeks		Comments RL
2.1.7	List of equipment	Preliminary	RL, 2 weeks		Comments RL
2.1.8	List of piping and valves		4 weeks		
2.1.9	List of pipe fittings		4 weeks		
2.1.10	Foundation drawings, arrangement of bolts, load diagrams		4 weeks		
2.1.11	Drawings of installation and erection		5 weeks		
2.1.12	As-built drawings		2 weeks after delivery		
2.1.13	Detailed list of materials	Preliminary	RL, 4 weeks		Comments RL
2.1.14	Nameplate drawings		4 weeks		
2.1.15	General layout drawings	Preliminary	RL, 2 weeks		Comments RL

DOCUMENTATION TO BE SUBMITTED BY THE SUPPLIER					
ITEM	PROJECT DOCUMENTATION	DELIVERY PLAN (Weeks after purchase order)			NOTES
		INFORMATION REQUIRED WITH TENDER	DOCUMENTATION FOR COMMENTS AND APPROVAL	DOCUMENTATION FOR INFORMATION AND RECORD	
2.1.16	Calculations	Preliminary	RL, 2 weeks		Comments RL
2.2	ELECTRICAL DOCUMENTS				
2.2.1	One-line diagram	Preliminary	*		
2.2.2	List of electrical equipment	Preliminary	*		
2.2.3	General electrical datasheets	Preliminary	*		
2.2.4	Electrical equipment technical datasheets	Preliminary	*		
2.2.5	Dimensional drawing and datasheets for each of the electric motors over 18,5 kW and motor-driven valve actuators	Preliminary	*		
2.2.6	List of equipment power consumptions, indicating rated power and voltage level	Preliminary	*		
2.2.7	Dimensional drawings for electrical equipment, detailing cable inlet area	Preliminary	*		
2.2.8	Schematic and wiring diagram for the inner and outer parts of electrical equipment		*		
2.2.9	List of cable types with characteristics		*		
2.2.10	List of cables		*		
2.2.11	Reports and certifications of tests performed		*		
2.2.12	Drawing with lighting fixtures and power outlets, if applicable		*		
2.2.13	Layout drawings for electrical equipment and tray and conduit routing		*		
	FOR MOTOR CONTROL CENTRES, MISCELLANEOUS PANELS AND CABINETS		*		
2.2.14	Installation conditions to ensure compliance with European Directive 89/336/CEE		*		
2.2.15	Base mat drawings (indicating weights and cable manhole)		*		
2.2.16	Equipment layout drawing		*		
2.2.17	Electrical diagrams for internal wiring		*		
2.2.18	Drawings and information on all pieces of equipment and accessories		*		
2.2.19	List of components and materials		*		
2.2.20	Data sheets		*		

DOCUMENTATION TO BE SUBMITTED BY THE SUPPLIER					
ITEM	PROJECT DOCUMENTATION	DELIVERY PLAN (Weeks after purchase order)			NOTES
		INFORMATION REQUIRED WITH TENDER	DOCUMENTATION FOR COMMENTS AND APPROVAL	DOCUMENTATION FOR INFORMATION AND RECORD	
2.3	INSTRUMENTATION AND CONTROL DOCUMENTS				
2.3.1	Functional description	Preliminary	RL, 2 weeks		
2.3.2	List of instruments		RL, 4 weeks		
2.3.3	List of anticipated inputs/outputs wired to the DCS		4 weeks		
2.3.4	List of final inputs/outputs wired to the DCS		8 weeks		
2.3.5	List of anticipated inputs/outputs to the PLC		2 weeks		
2.3.6	List of final inputs/outputs to the PLC		8 weeks		
2.3.7	PLC and dialog terminal source programs		5 weeks		Comments RL
2.3.8	Factory acceptance test protocol		3 weeks before control panel tests		
2.3.9	Physical layout of I&C instruments and equipment		2 weeks		
2.3.10	Data sheets of instruments and control valves		4 weeks		
2.3.11	Details for instrument assembly and installation		10 weeks		
2.3.12	PLC control diagrams		6 weeks		
2.3.13	Design of operating diagrams to be implemented in the dialog terminal		6 weeks		
2.3.14	Operating and maintenance manuals for I&C instruments and equipment		10 weeks		
2.3.15	Startup and plant test procedures		2 weeks before FAT		
2.3.16	Manufacturer's documentation		4 weeks after provisional acceptance		
3.	**QUALITY DOCUMENTS**				
3.1	Test procedures and report				
3.1.1	Material compliance certificate			Available at delivery	
3.1.2	Production tests			*	
3.1.3	Radiography report			Available at delivery	
3.1.4	Leaktightness and hydrostatic test procedures	Preliminary	4 weeks		

DOCUMENTATION TO BE SUBMITTED BY THE SUPPLIER					
ITEM	PROJECT DOCUMENTATION	DELIVERY PLAN (Weeks after purchase order)			NOTES
		INFORMATION REQUIRED WITH TENDER	DOCUMENTATION FOR COMMENTS AND APPROVAL	DOCUMENTATION FOR INFORMATION AND RECORD	
3.1.5	Leaktightness test report			Available at delivery	
3.1.6	Hydrostatic test report			Available at delivery	
3.1.7	Workshop reports			Available at delivery	
3.1.8	Electrical test procedure		*		
3.1.9	Painting procedures		4 weeks		
3.1.10	Painting reports			Available at delivery	
3.1.11	Vibration and noise test procedures		6 weeks		
3.1.12	Functional test procedures		8 weeks		
3.1.13	Functional test report			Available at delivery	
3.1.14	Non-destructive test procedures			Available 4 weeks before manufacturing	
3.1.15	PQR & WPS			Available 4 weeks before manufacturing	
3.1.16	Quality plan	Preliminary		RL, 4 weeks	
3.1.17	Inspection points programme	Preliminary	RL, 2 weeks		
3.1.18	Documented reports on deviations, if applicable			*	
3.1.19	Declarations and certificate of conformity with the different European Directives applicable		1 week before delivery		
3.2	Manuals and dossiers				
3.2.1	Operating and maintenance manual (including those for electrical equipment)		16 weeks		
3.2.2	Documentation for training courses		16 weeks		
3.2.3	Official project documentation (PED)		8 weeks		
3.2.4	Final engineering dossier		2 weeks after delivery		
3.2.5	Final quality dossier			2 weeks after delivery	

APPENDIX E

SPECIFIC REQUIREMENTS FOR TESTING AND REPORTING NOISE AND VIBRATIONS

E.1 NOISE

1. GENERAL

After the contract award the equipment Supplier will be required to submit report and calculations justifying all noise values guaranteed for approval.

Report shall include:

- Estimated octave band sound power levels
- Octave band sound pressure levels of equipment
- Overall dimensions of the equipment (L, W, H)
- Description of any noise treatment measures needed to meet the near filed sound pressure level requirements

Any impact on maintainability due to the use of noise abatement measures will be documented by Supplier.

2. ACCEPTANCE TESTS

2.1 BASIS FOR NEAR FIELD NOISE GUARANTEE

Noise guarantee acceptance tests shall be conducted by the Supplier in accordance with ANSI/ASME PTC-36-1985 or equivalent. The noise limit(s) specified shall not be exceeded.

Measurements shall be taken 1 m (3 ft) away from the outermost exterior surfaces of equipment including piping, conduit, framework, barriers and personnel protection devices if provided.

Measurements shall not be taken in any location where there is an airflow velocity greater than 1.5 m/s (5 ft/s) including nearby air intakes or exhausts.

Note: Additional references ISO 3740 Series, DIN45635 and ISO 9614-2 are applicable for general noise test requirements.

3. TEST REQUIREMENTS

When the Purchaser considers it necessary, a noise guarantee acceptance test will be performed as described below, at site by the Supplier in the presence of the Purchaser or his representative. The Purchaser shall notify Supplier at least ten (10) working days prior to the date on which the test is to be made so that the Supplier or his representatives may be present.

A noise test procedure will be prepared by the Supplier and approved by the Purchaser before the test is performed. The test plan must adhere to the listed requirements and include provisions for a test report, which must be submitted to the Purchaser 30 days after the noise test

All equipment noise sources must be considered for the test.

Purchaser reserves the right to perform such tests at the same time that the unit is tested for rating performance guarantee.

Octave band sound pressure levels shall be measured in decibels (dB, re: 20 μPa). The levels listed in the Data Sheets are maximum levels that shall not be exceeded when measured at the indicated distance from the equipment or assembly of 1 m.

Unless otherwise specified, octave band levels shall not be converted to a single equivalent dBA sound level for measuring compliance.

4. MEASURING EQUIPMENT

A type-1 precision sound level meter, including microphone as specified in IEC60651, shall be used to measure overall noise levels.

The sound level meter shall have an octave band filter set, Type E, Class II, as specified in IEC61260, that shall be used for measuring octave sound levels.

If recorders are to be used, they shall have the same characteristics as the meter and microphone described above.

Instrument shall be acoustically calibrated in accordance with ISO Standard 3746 and as recommended by the instrument manufacturer. Overall calibration of the

instruments, including the microphone and internal calibration of the meter, shall be made before and after each test series. A calibration level variation greater than 0.5 dBA may require repeating the test series.

A calibrated wind screen shall be used, if necessary. Its effect on response of the meter shall be less than 0.5 dB at frequencies below 2000 Hz and less than 1.0 dB for frequencies between 2000 Hz and 10000 Hz.

5. TEST PROCEDURE

Test procedure shall be per the applicable sections of ANSI/ASME PTC 36, unless otherwise specified herein or in the related specifications.

Location and orientation of the microphone shall be identical for measurement of ambient noise levels.

The microphone shall be placed so that it is protected from air currents, vibration, electric fields, magnetic fields and any other influences that might affect the readings. The microphone shall not be acoustically shielded from the equipment.

Measurements shall be made in octave bands. For pulsating or cyclical sound levels, the maximum sound level as read on the meter slow response shall be recorded.

Unless otherwise specified, equipment shall be tested at full load. If noise levels in a less than fully loaded conditions exceed levels for the loaded condition, then the Supplier shall so specify.

6. NOISE LIMITS

The results shall not exceed the noise levels required in the specification and data sheets when following the procedures and requirements described above. Any remedial work performed by either Purchaser or Supplier as a result of the Supplier's failure to meet the guaranteed noise levels shall be at the expense of the Supplier. Equipment shall be made available for remedial work at the time designated.

Purchaser reserves the right to reject any item which, when tested as described herein, does not meet the required limits.

EMPRESARIOS AGRUPADOS

NOISE ANALYSIS REPORT

Sheet of

Date

Project / Nº Id.:

Specification Ref.:

Document Id / Rev.:

Equipment Location at site

Outdoors / Indoors: Room:

Building: Equip. Elev.:

NOISE EMISSION DATA SHEET

Basis of noise data & Test conditions

Shop or Site Test / Other:

Standard Applied:

Operating mode (Base / Transient):

Additional Information

EQUIPMENT NOISE DATA (NOTES 1, 2)

Equipment Description	Nº of Units	Equipment Dimension (m)			Sound Power (Octave Bands) Hz Lw (dB)										Sound Pressure at 1 meter
		Length	Width	Height	31.5	63	125	250	500	1000	2000	4000	8000	A-wt	Lp (dBA)

and relevant position of the sound meter for Lp measurements:

(1) Noise data and service conditions table to be filled by equipment supplier. Identify equipment, noise test code and operating modes related to noise emission (Values determining according to noise test code given in standard XXXX, using the basic standards YYYY & ZZZZ). Shall be declared for each operating mode specify in the appropriate test code (at least base load and transient operation). If not exist, the guidance given in the reference basis standard. Reference basic standards are EN-ISO 3740 series, ANSI S12.3x series, EN-ISO 9614-2, ANSI/ASME B133.8, ASME PTC 36, EN-ISO 11200 series, DIN 45635

(2) The highest practicable grade of accuracy shall be use to declare noise emissions.

Definitions:

L_W: Sound Power Level (dB re 10^{-12} W)

L_P: Sound Pressure Level at a stated position (dB 2x re 10^{-5} Pa)

E.2 VIBRATION

1. ACCEPTANCE TESTS

Noise guarantee acceptance tests shall be conducted by the Supplier in accordance with the ISO 7919, 10816 standards applicable or equivalent, as applicable, so the specified vibration limits are not exceeded.

Measurements shall be performed on-site.

The test results shall not exceed the vibration limits required in the specification and data sheets.

Any remedial work performed by either the Purchaser or the Supplier as a result of the Supplier's failure to meet the guaranteed vibration levels shall be at the expense of the Supplier.

Equipment shall be made available for remedial work at a time designated by the Purchaser.

The Purchaser reserves the right to reject any item which, when tested as described herein, does not meet the required limits.

2. TEST REQUIREMENTS

Whenever the Purchaser considers it necessary, a vibration guarantee acceptance test shall be performed on-site by the Supplier in the presence of the Purchaser or his representative, as described below. The Purchaser shall notify the Supplier at least ten (10) working days prior to the date on which the test is to be made so that the Supplier or his representatives may be present.

A vibration test procedure shall be prepared by the Supplier and approved by the Purchaser before the test is performed. The test plan must adhere to the requirements listed and include provisions for a test report, which must be submitted to the Purchaser 30 days after the test.

The Purchaser reserves the right to perform such tests at the same time as the unit is tested for rating performance guarantee.

EMPRESARIOS AGRUPADOS	**VIBRATION TEST DATA SHEET**	Sheet 1 of 1 Issue Sheet: Date:

Project/Id: Ref. Specification:

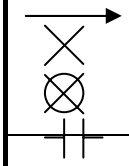
Document Id: Equipment Id:

Basis of vibration data & test conditions

Shop or Site Test/Other:

Operating Modes:

SYMBOLS



Measuring point
Bearing
Roller bearing
Coupling

Sketch and relevant positions of the vibration measurements

SENSOR POSITION		BROAD BAND FILTER			NARROW BAND FILTER					
		Displace-ment	Speed	Acceptance value (limit A/B)	Displace-ment	Frequency	Speed	Frequency	Acceptance value (limit A/B)	Remarks
		μm	Mm/s	(μm // mm/s)	μm	Hz	mm/s	Hz	(μm // mm/s)	
Magnitude*→		( )	( )	( )	( )		( )		( )	
	H									
	T									
	A									
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	A									
	H									
	T									
	A									

Reference standard:

Acceptance values*: A/B(__), B/C(__) unit(_____)

Alarm and shutdown values*

Evaluation of results and notes:

*Indicate magnitude (RMS, peak, peak-peak) /// H: Horizontal T:Transversal A: Axial (machine axis)

Operating conditions:

Speed (rpm):

Temperatures:

Other mechanical and electrical equipment operating parameters:

Test equip ID:

	SIGNATURE	DATE
Performed by		
Supervised by		

Notes:

(1) Identify equipment, vibration test code and operating modes related to vibration test measurements (shall be applied to each operating mode). Reference basic standards for vibration testing are ISO 7919 and 10816. Other basic ISO standards for vibration providing recommendations for measurements and evaluation criteria pertaining to specific machine types can be used.

(2) Include reference information on the supply, such as reference values, measuring points and directions, operating conditions, etc.

APPENDIX F

CONTENTS OF THE BILL OF MATERIALS DOCUMENT

Master Bill of Materials

Scope

A master bill of materials shall identify all equipment, components, devices, etc in a master list to aid in shipping and receiving processes. The master bill of materials and packing lists shall be sent with the shipment and a copy shall be sent to the Purchaser at the time of shipment.

Master Bill of Materials

A master Bill of Materials (BM) shall be developed. The BM shall include, but not be limited to, all equipment, major components, devices, motors, instruments, piping specialities, control panels, major electrical components, etc. Tag numbers whether provided by Purchaser or the Supplier shall be assigned to motors, panels, pumps, instruments, safeties, etc and shall be itemised on the BM.

The BM shall identify: job number, purchase order number, purchase order item number, name of item, tag number, manufacturer's name, model number, and if the item is part of a skid and which skid, or is the item shipped loose.

A preliminary BM shall be supplied with the bid. A second BM shall be supplied after general arrangements are approved (if it is different from the preliminary BM) and a final to be issued prior to shipping.

List of equipment for use in potentially explosive atmospheres

This list shall include all the equipment qualified to potentially explosive atmospheres in accordance with ATEX Directive 94/9/CE. The format of the list may be found in Appendix H. The statement of agreement with Directive 94/9/CE of the equipment included in the aforementioned list shall be sent attached to this list.

Assembly Drawings

All assembly drawings shall be listed in the BM. Each assembly drawing shall clearly identify all components with the appropriate tag number and KKS. The assembly drawings shall identify which items are shipped as part of the assembly or are shipped loose.

Packing Lists

Packing lists shall identify, in a clear and concise manner, items listed in the Bill of Materials or assembly drawings such that Purchaser for each shipment can identify that each element of the contract or purchase order that has been received is; in proper condition; whether it is a complete assembly, partial assembly, or loose item. The packing lists shall list applicable assembly drawings and elements provided with tag numbers (Purchaser or equipment supplier).

Packing lists for any item shipped loose or as a subassembly separate form the primary assembly and without a tag number or assigned identification number (eg piping components wiring harnesses, etc) shall identity the assembly drawing where the item is best shown. The packing list shall also include identification markings designated by the Supplier, as shown on the referenced assembly drawing.

APPENDIX G

PIPING DATASHEET

See document 428-00-R-M-00403 *Pipe Data Sheets*.

APPENDIX H

I&C REQUIREMENTS

1. GENERAL

The control of the compressed air system shall be designed so that plant operation is completely automatic and unattended by the operator. For this purpose, the system shall be equipped with all the instrumentation that the compressed air plant supplier deems necessary to fulfill this function.

The basic functions of the control system shall be as follows:

- To maintain an adequate air pressure value in the compressed air drum
- To maintain a percentage of moisture that does not damage the valves or instruments

2. INSTRUMENTATION

All the system instrumentation shall comply with the requirements set out in document No. 428-00-R-I-00400, *Specification of DCS Interface with Package Plants* and document No. 428-00-R-I-00500, *I&C Requirements for Piping and Mechanical Equipment*.

The scope of supply for the compressed air system supplier includes all the instrumentation and air-operated valves that are necessary to allow plant operation to be completely automated, as well as all the equipment and materials that are needed for their manufacture, erection, testing and final installation.

As a minimum, the supplier shall install the instruments represented in the P&ID that is attached to this specification. Should the supplier require more instrumentation or pneumatic valves to attain a completely automatic control of the system, these valves shall be represented in the P&ID that must be attached to the bid.

3. CONTROL SYSTEM

The complete control and local supervision of the system shall be done from the PLC that shall be installed in the local control panel (KKS: 00SCA10GH001). The supplier shall therefore program the system control logic so that any decision about the overall operation of the equipment is governed from the PLC.

The PLC must control the startup and automatic stop of the compressors as a function of the selected time alternation, as well as the startup and automatic shutdown of the dryers, the valve alignment, the permits for any remote actuation, the selection of an equipment item as main or standby, the generation of alarms that alert the operator of any danger, etc.

The protections and logics that are preprogrammed in a standard way for the compressors and dryers (blowdown and regeneration cycles, etc) can reside in the corresponding microprocessors of each machine.

4. OPERATION

The compressors and dryers can be operated in the following two modes:

a) **Local**: this mode shall be selected by placing the local/remote selector on each of the control boards of both machines on 'Local'.

The compressors shall start up or shut down, depending on the values adjusted for the suction and discharge of each compressor, to maintain the discharge pressure of said compressor.

The dryers shall start up upon a manual command from the local control of each individual dryer.

When on local mode, the equipment shall operate independently, and it shall be up to the Operator to decide how to align the compressors with the dryers. In this operating mode, two compressors can operate at the same time, although there shall be a protection against high pressure in the instrument air drum or the service air drum that will stop one of the two. This protection shall always be present regardless of the operating mode that is selected.

In this operating mode, if a compressor or dryer in operation trips for any reason the redundant standby equipment shall not start up.

b) **Remote**: this mode shall be selected by placing the local/remote selector on each of the control boards of the compressors and dryers on 'Remote'.

In this mode, the compressors shall maintain the air pressure in the instrument air drum instead of that of its discharge. All external control to the compressor units shall be done by the PLC.

The compressors and dryers shall alternate so that they operate for a similar amount of hours. Under normal conditions, a compressor shall remain on

standby, although both may operate simultaneously if there is a demand of production of air.

The alternation in the times of operation for the compressors and dryers may be total or partial:

- **Total alternation**: in this mode, the equipment item assigned as main shall remain in operation as long as the established hours of operation are not reached. Once this limit is reached, the priority of the equipment shall be inverted, so the equipment item that was on standby shall be assigned as main and viceversa. The value of time of operation may be modified by the Operator in the PLC of the Compressed Air System. The total time in operation of the equipment being alternated shall be constantly added up until the Operator voluntarily resets it from the panel of the system PLC.

- **Partial Alternation**: this mode is similar to the above, with the sole exception that the accumulated time for the alternation of the equipment is considered since the last time the equipment was started up, so every time the priority of the equipment is changed, their time is resetted. Thus, the alteration times are established since the last time that the equipment item entered operation as primary equipment, without considering the total hours of operation, as in the case of total alternation.

Regardless of the type of alternation that is selected, the trip of one of the equipment items shall make the standby equipment enter operation.

4.1 SIGNALS TO BE EXCHANGED WITH THE DCS

All the command signals to be exchanged with the DCS shall be connected by means of conventional hardwiring, including those such as permissives which are linked to said commands.

The signals to be exchanged with the DCS shall comply with the requirements set out in document No. 428-00-R-I-00400 *Specification of DCS Interfaces with Package Plants*.

The PLC will receive the following commands and information from the DCS:

- Remote start command, air compressor 1 (KKS: 00SCA10AN001XT01)
- Remote start command, air compressor 2 (KKS: 00SCA20AN001XT01)

- Remote stop command, air compressor 1 (KKS: 00SCA10AN001XT02)
- Remote stop command, air compressor 2 (KKS: 00SCA20AN001XT02)
- Remote start command, tower dryer (KKS: 00SCA10AH001XT01)
- Remote stop command, tower dryer (KKS: 00SCA10AH001XT02)
- Compressor 1 lead/lag selection (KKS: 00SCA10AN001XT58)
- Compressor 2 lead/lag selection (KKS: 00SCA20AN001XT58)

The PLC will send to the DCS, the following information:

- Air compressor 1 started (KKS: 00SCA10AN001XS01)
- Air compressor 2 started (KKS: 00SCA20AN001XS01)
- Tower dryer running (KKS: 00SCA10AH001XS01)

Alarms

This system sends to the DCS the following alarms:

- Air compressor 1, general alarm not actuated (KKS: 00SCA10AN001XS25)
- Air compressor 2, general alarm not actuated (KKS: 00SCA20AN001XS25)
- Tower dryer, general alarm not actuated (KKS: 00SCA10AH001XS25)
- High dif. Pressure in the dryers inlet strainers (KKS: 00SCA10GH001JH01A)
- High dif. Pressure in the dryers outlet strainers (KKS: 00SCA10GH001JH02A)
- Air compressor 1, not tripped (KKS: 00SCA10AN001XS15)
- Air compressor 2, not tripped (KKS: 00SCA20AN001XS15)
- PLC not fail (KKS: 00SCA10GH001XS11)

Supervision signals shall be transmitted by datalink.

ID PANEL (1)	00SCA10GH001		
SERVICE (2)	Local control panel for compressed air		
SIGNAL ID (KKS) (3)	**SIGNAL DESCRIPTION** (4)	**CONEXIÓN POINT** (5)	**COMMENTS**
00SCA10AN001XT01	Remote start command, air compressor 1	Board XA, terminal 1 ; 2 ; P1	
00SCA10AN002XT01	Remote start command, air compressor 2	Board XA, terminal 3 ; 4 ; P2	
00SCA10AN001XT02	Remote stop command, air compressor 1	Board XA, terminal 5 ; 6 ; P3	
00SCA10AN002XT02	Remote stop command, air compressor 2	Board XA, terminal 7 ; 8 ; P4	
00SCA10AH001XT01	Remote start command, tower dryer	Board XA, terminal 9 ; 10 ; P5	
00SCA10AH001XT02	Remote stop command, tower dryer	Board XA, terminal 13 ; 14 ; P7	
00SCA10AN001XT58	Compressor 1 lead/lag selection	Board XA, terminal 17 ; 18 ; P9	
00SCA10AN002XT58	Compressor 2 lead/lag selection	Board XA, terminal 19 ; 20 ; P10	
00SCA10AN001XS01	Air compressor 1 started	Board XB, terminal 1 ; 2 ; P1	
00SCA10AN002XS01	Air compressor 2 started	Board XB, terminal 3 ; 4 ; P2	
00SCA10AT001XS01	Tower dryer running	Board XB, terminal 5 ; 6 ; P3	

NOTES:

(1) Indicate KKS identification of the box (2nd level)

(2) Indicate panel description

(3) Indicate KKS identification of the signal (3rd level)

(4) Indicate signal description

(5) Indicate wire terminal identification and corresponding board

Exceptions:

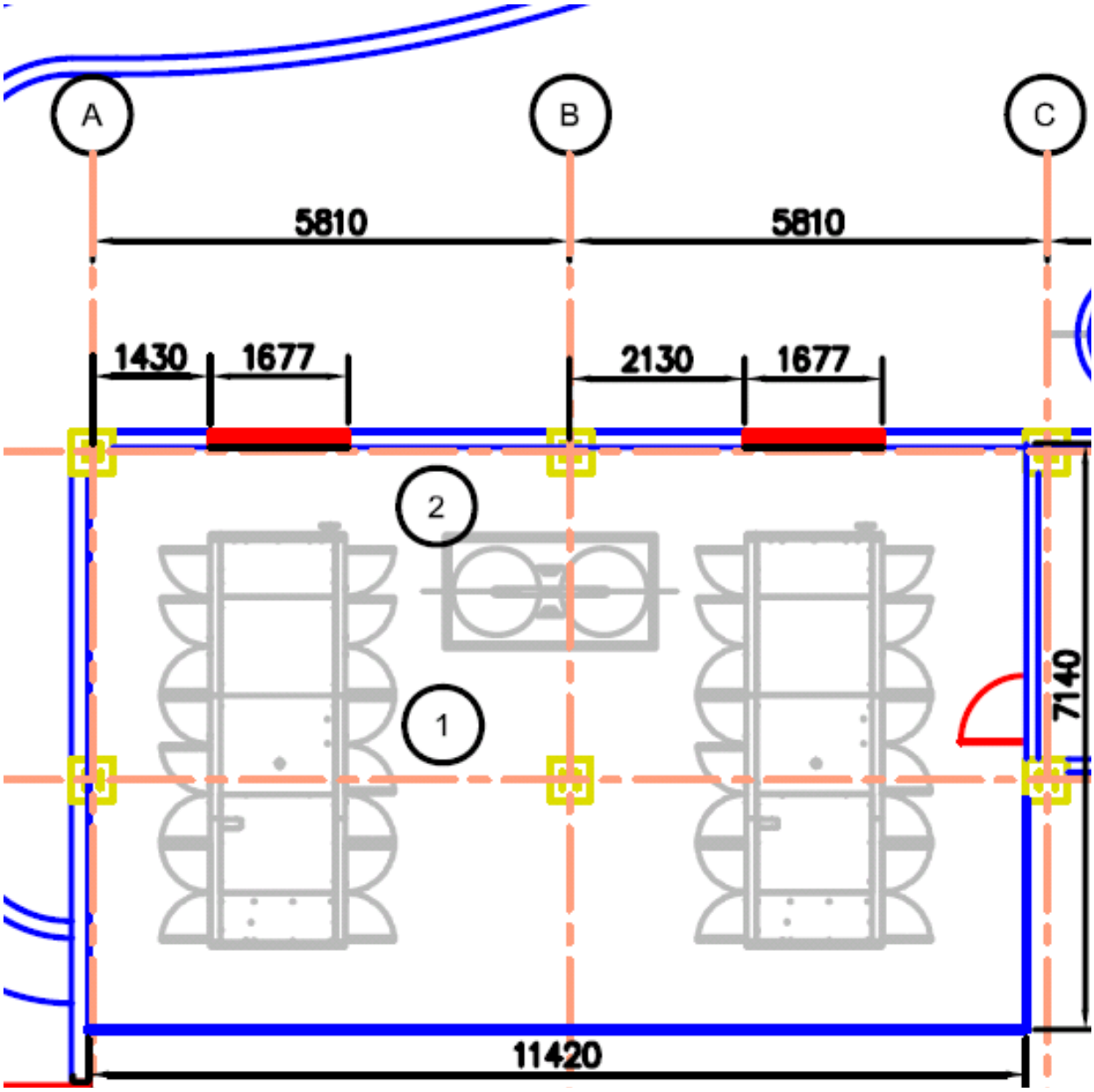
SERVICE (2)	Local control panel for compressed air		
SIGNAL ID (KKS) (3)	**SIGNAL DESCRIPTION** (4)	**CONEXION POINT** (5)	**COMMENTS**
00SCA10AN001XS25	Air compressor 1, general alarm not actuated	Board XB, terminal 9 ; 10 ; P4	
00SCA10AN002XS25	Air compressor 2, general alarm not actuated	Board XB, terminal 11 ; 12 ; P5	
00SCA10AT001XS25	Tower dryer, general alarm not actuated	Board XB, terminal 13 ; 14 ; P6	
00SCA10AN001XS15	Air compressor 1, not tripped	Board XB, terminal 17 ; 18 ; P7	
00SCA20AN001XS15	Air compressor 2, not tripped	Board XB, terminal 19 ; 20 ; P8	
00SCA10GH001XS11	PLC not fail	Board XB, terminal 21 ; 22 ; P9	

NOTES:
(1) Indicate KKS identification of the box (2nd level)
(2) Indicate panel description
(3) Indicate KKS identification of the signal (3rd level)
(4) Indicate signal description
(5) Indicate wire terminal identification and corresponding board

Exceptions:

APPENDIX I

COMPRESSED AIR PLANT GENERAL ARRANGEMENT



CLASSIFICATION

Contains information for the design of structures, systems or components: Yes ☒ No ☐

Design verification : Not applicable ☐ Head of OU/Supervisor ☒ Verifier Level 1 ☐ Level 2 ☐

CONTROL OF MODIFICATIONS

Issue	Modifications
1	Not applicable, first issue

PRELIMINARY OR PENDING INFORMATION

Issue	Paragraphs	Subject	Status
1	3.9	Typical details of assembly of electrical raceways and cable runs	Pending
	4.1.2, 4.2, 6.2	Short-circuit levels and power factor in short-circuit conditions	Preliminary
	6.2	Cross-section of LV motors power supply cables	Preliminary
	4.1, 4.2, 6.2	Cross-section of the grounding conductors	Preliminary
	Appendix F	Qualified manufacturers	Pending

DISTRIBUTION

External	Internal	No. copies/Format
COBRA: Imanol Ruíz		1/electronic file
	JSW, PJR, GOM, LPD, AGD	1/electronic file

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1. PURPOSE

The purpose of this document is to establish the electrical requirements for the electrical equipment included in the mechanical equipment and package plants of the Lares Combined Cycle Power Plant in Portugal.

The present document is considered as an integral part of the specifications for mechanical equipment and package plants that it accompanies; said specifications are referred to as “main specification” hereinafter.

Unless indicated otherwise in the main specification, the electrical requirements included in the present document are mandatory to the full extent applicable for the supply of equipment and components, in order to achieve homogeneous electrical design for all the facilities comprised in the combined cycle power plant.

2. SCOPE OF SUPPLY

2.1 GENERAL

For the purpose of establishing the limits of the electrical supply, the “electrical systems” of a package plant are defined as the ones formed by the power transformation and distribution equipment, electrical machines and end consumers, with their associated protection and control devices, electrical cables for interconnection and their raceways, as well as by the rest of auxiliary services, such as equipment grounding, raceway sealing, etc, which forms part of the “electrical installation” of the package plant.

In the case of a package plant, the electrical equipment to be supplied includes, unless otherwise indicated in the main specification, the motor control centres (MCCs) and miscellaneous low voltage switchgear and switchboards, power machines and consumers, control electrical cabinets, power and I&C cables, and all associated electrical raceways, as well as their erection, testing and commissioning.

The electrical installation to be supplied begins at the power supply connection points in the conditions indicated. Its scope corresponds to the complete installation ready for operation, and only missing the power supply connection from the power plant to the distribution transformer or to the switchgear as applicable, to be provided by the Supplier, from where the package plant electrical systems will be fed, at the voltage required, and with the necessary control interconnections.

Notwithstanding the equipment items, services and documentation requested for the “electrical systems” of the package plant, the Supplier shall be responsible for the preparation of the complete set of control and wiring schematics, including the package plant interfaces with the exterior and the identification of all equipment items, cables, trays, ducts and conduits, in accordance with the project identification system indicated in subsequent chapters of this document.

Unless otherwise noted in the main specification, equipment grounding shall be included in the supply and shall consist of the grounding conductors extending from the equipment items to the general grounding strip of the building (not within the scope) or to the general buried grounding network (not included in the scope).

Lighting and communications (public system and intercom systems, and telephone systems) are not included in the supply, unless indicated otherwise in the main specification.

Depending on the mechanical supply dealt with, the above scope may be modified to a greater or lesser degree.

Any restriction or limitation in the established scope of supply shall be explicitly indicated in the main specification.

2.2 EQUIPMENT

The Supplier's specific scope of electrical equipment supply is established in the main specification in each individual case.

Regardless of their power, electric motors will form part of the Supplier's scope in all cases.

The equipment must be manufactured by one of the qualified manufacturers indicated in Appendix F. If the Supplier proposes a different manufacturer to those indicated, it must be approved by the Purchaser.

2.3 EQUIPMENT SUPPLIED BY OTHERS

The following equipment items shall be supplied by the Purchaser:

a) In all cases, distribution boards with starters for motors over 75 kW (6.6 kV withdrawable circuit breakers for motors rated >200 kW and 400 V circuit breaker withdrawable units for motors with rated power greater than 75 kW and equal or less than 200 kW)

   Note: Unless otherwise explicitly indicated in the main specification the Purchaser shall provide the LV MCCs with starters for motors whose rated power is equal to or less than 75 kW (moulded-case circuit breaker with contactor and differential thermal relay installed in draw-out cubicles)

b) Other distribution boards out of the scope of the Supplier which provide the power and control supplies that require the Supplier's mechanical and electrical equipment, with the specifications established in section 3.4 of this document

c) Power, control and instrumentation cables between motors and the distribution board, when the Purchaser supplies the starter

d) Power and control cables outside the scope of supply up to the distribution boards or panels provided by the Supplier and, in general, cables to connect with other plant equipment outside the scope of supply

e) Lighting

Nevertheless, in the case of package plants the Supplier shall propose the lighting fixtures and power outlet installation points

f) Grounding underground network or building general grounding strip

g) Lightning protection system

h) Communications (loudspeakers and telephony)

i) Civil works for basemats

2.4 SERVICES

The Supplier's scope of services shall be that indicated in the main specification, and shall in any case comprise the following:

a) Supply of the documentation required in chapter 12 of this document

b) Tests of the electrical equipment supplied

c) Packing, transport, assembly and commissioning, performed in accordance with the indications of the main specification.

3. GENERAL REQUIREMENTS

3.1 DESIGN LIFE

The plant equipment shall be designed for a minimum useful life of 25 years, operating at full load for an equivalent of 8000 hours per year.

3.2 DESIGN ENVIRONMENTAL CONDITIONS

3.2.1 Design Climatic Conditions

The climatological and environmental parameters applicable to the electrical facilities and to the electrical equipment located outdoors shall be as follows:

- Design Ambient Temperature / Relative Humidity 14.9°C / 80%
- Maximum Ambient Temperature / Relative Humidity 38.6ºC / 69%
- Minimum Ambient Temperature / Relative Humidity -2.5ºC / 88%
- Barometric pressure 1013 mbar
- Maximum wind design speed 210 km/h
- Elevation 7 m
- Location Coastal
- Exposure to sun Direct

The electrical equipment located indoors shall be designed for a maximum ambient air temperature of 40ºC.

3.2.2 Seismicity

Seismic action is defined for the Lares site in the RSA Code (*Regulamento de Segurança e Acçoes para Structuras de Edificios e Pontes. Decreto Lei nº 235/83 de 31 de Maio*), Chapter VII and Annex III. Earthquake (Seismic) loads are based on the following parameters:

- Zone C
- Soil type III
- Seismic coefficient α = 0.5

3.2.3 Environment

The environment is aggressive and corrosive.

A considerable amount of salt is contained in the atmosphere, giving rise to corrosion attacks, given the ambient humidity.

3.3 CODES AND STANDARDS

Unless otherwise specified, electrical equipment and components shall comply with the codes and standards indicated below.

They shall be applicable in the editions in force on the date of award of purchase order, including modifications.

3.3.1 European and International Standards

EN and IEC standards applicable to the equipment. When there are no applicable EN or IEC standards, other internationally recognised codes and standards can be used, such as:

ANSI *American National Standards Institute*

IEEE	*Institute of Electrical and Electronic Engineers*
NEMA	*National Electric Manufacturers Associations*
VDE	*Verband Deutcher Elektroteknischer*
ISO	*International Standards Organization*
ASTM	*American Society for Testing Materials*
CCITT	*Consultative Committee for International Telephony and Telegraphy*
NFPA	*National Fire Protection Association*

3.3.2 European Directives

73/23/EEC	*Electrical Equipment Designed for Use within Certain Voltage Limits*
89/336/EEC	*Electromagnetic Compatibility*
1999/92/EC	*Minimum Requirements for Improving the Safety and Health Protection of Workers Potentially at Risk from Explosive Atmospheres*
94/9/EC	*Equipment and Protective Systems Intended for Use in Potentially Explosive Atmospheres*
98/37/EC	*Machinery*
93/68/EEC	*Evaluation of Conformity with CE marking*

3.4 SUPPLY VOLTAGES

The plant will supply the package plant supplier with the following power: 6.6 kV, three phase, 50 Hz for motors rated higher than 200 kW; 400 V, three phase, 50 Hz for LV motors and normal power circuit supply; 400/230 V, three-phase and neutral, 50 Hz for lighting and miscellaneous services, and 230 V, single-phase and neutral, 50 Hz (UPS) exclusively for the PLCs. The remaining voltages required by package plant electrical systems (control, instrumentation, etc) shall be obtained by the Supplier from the above, providing the required voltage levels and ranges given below. Exceptionally, 125 Vdc shall be supplied to power control/instrumentation equipment that require it.

The standard supply voltages for plant electrical systems are as follows:

3.4.1 Medium Voltage System

- Nominal voltage, Un — 6.6 kV
- Frequency — 50 Hz
- Voltage variation margins during continuous operation in the terminals of the consumers — 0.90 ÷ 1.10 Un
- Minimum voltage value in motor terminals during startup — 0.80 Un
- Minimum transient voltage value in motor terminals during operation — 0.70 Un
- Neutral grounding — Low value resistor with 600 A earth limiting fault
- Distribution — Three-phase without neutral (three wires)

3.4.2 Low Voltage System (Power Centres and MCCs)

- Nominal voltage, Un — 400 V
- Frequency — 50 Hz

- Voltage variation margins during continuous operation in the terminals of the consumers — 0.90 ÷ 1.10 Un
- Minimum voltage value in motor terminals during startup — 0.80 Un
- Minimum transient voltage value in motor terminals during operation — 0.70 Un
- Neutral grounding — Solidly grounded
- Distribution — Three-phase without neutral (1)

(1) Except for the cases defined in Chapter 9 of this document, where equipment is grounded through the earthing conductor included in the associated power cable. In such cases, the distribution will be three-phase + G (four wires).

3.4.3 Lighting and Miscellaneous Services System

- Nominal voltage, Un — 400/230 V
- Frequency — 50 Hz
- Voltage variation margins during continuous operation — 0.90 ÷ 1.10 Un
- Neutral grounding — Solidly grounded
- Distribution to consumers — Three-phase with neutral (four wires) or Single phase with neutral (two wires)

3.4.4 DC System for Control

- Nominal voltage, Un — 125 V
- Voltage variation margins during continuous operation at consumer terminals — 0.80 ÷ 1.10 Un
- Grounding — Ungrounded poles
- Distribution — Two wires

3.4.5 Uninterruptible Power Supply (UPS) System

• Nominal voltage, Un	230 V
• Frequency	50 Hz
• Voltage variation margins during continuous operation at consumer terminals	0.90 ÷ 1.10 Un
• Neutral grounding	Solidly grounded
• Distribution	Single-phase with neutral (two wires)

3.5 LOAD SUPPLY CRITERIA DEPENDING ON THE POWER RANGE

The various electrical distribution boards are generally devoted to the following types of consumer:

3.5.1 Medium Voltage Switchgear

- Motors with power greater than 200 kW
- 6600/420 V distribution transformers

3.5.2 400 V Switchgear

- Motors with rating greater than 75 kW and equal or lower than 200 kW
- Low voltage motor control centres
- Other loads with current greater than 250 A

3.5.3 400 V MCCs

- Motors with power equal to or lower than 75 kW
- Local panelboards for power supply of motor-operated valves

- Other loads with current equal to or lower than 250 A

3.5.4 Lighting and Miscellaneous Service Switchgear

- Three-phase loads with neutral, for lighting, power outlets and non-process consumers

3.5.5 230 V Distribution Panels Installed in MCCs, Serviced from the Lighting and Miscellaneous Service Switchgear

- Single-phase outgoing feeders for heating and other single-phase loads with current no greater than 15 A

3.5.6 125 Vdc Board

- Direct current loads (except motors)

3.5.7 Uninterruptible Power Supply (UPS)

- The control and instrumentation equipment which require AC uninterruptible power supply

3.6 EQUIPMENT PROTECTION CLASS

The degrees of protection for electrical cabinets and equipment provided for indoor installation shall be given in later chapters (sections 4.1.3 and 4.2.1 for panels, 5 for MV motors, 6.2 for LV motors, and 7.1 for motor-operated valves).

In general, electric panels and equipment provided to be installed outdoors shall be designed with a degree of protection equal to or higher than IP54 according to IEC-60529.

3.7 INSTALLATION IN HAZARDOUS AREAS

The equipment, cables, conduits and connection accessories to equipment located in rooms or areas where the accumulation of gases, vapours, etc combined with air

may form explosive atmospheres shall be designed to comply with the requirements established in this respect in European Directives 94/9/EC and 1999/92/EC (ATEX), in the applicable harmonised EN standards, as well as in the applicable national and local standards and regulations.

3.8 MISCELLANEOUS REQUIREMENTS

3.8.1 Painting

The colour, characteristics and application method for equipment coatings and paint shall comply with the painting specification No. 428-00-I-M-27700.

The corresponding procedures for preparation, descaling, priming and painting shall be sent for Purchaser approval after the order has been awarded.

3.8.2 Noise

The noise level of each machine shall not exceed 85 dBA at a distance of 1 metre.

For the motors, a noise level of 80 dB(A) shall be considered, taking into account that the motor-driven equipment assembly does not exceed the maximum value indicated of 85 dBA or the one indicated in the main specification. Furthermore, the motors shall be in accordance with the NP-1733 “Estimativa de protecção durante o exercicio de uma actividade profissional com vista à protecção da audição” and DL 292/2000 “General Noise Regulations”.

3.8.3 Standardisation

The electrical switchgear and components of the package systems must have similar characteristics to those of the main Plant equipment. For this purpose, the Purchaser reserves the right to establish beforehand the manufacturer of the electrical power switchgear included in the supply of the package plants, as well as that of the motors.

3.8.4 Cable Entry

The entry of cables to the electrical equipment shall be done through the lower part.

The entry of cables to the equipment when the last section runs above ground shall be done using cable glands. The equipment terminal boxes shall be large and equipped with removable covers.

Whenever the electrical erection is included in the scope, the cable glands and any other accessory for the laying and connection of the cables shall be provided by the Supplier. In any other case, the terminal boxes shall be supplied with blind covers so that others can machine the assembly orifices of the cable glands onsite.

3.8.5 Nameplates

Electrical equipment shall be provided with the KKS code nameplates that have been assigned in the project in accordance with Document No. 428-00-R-D-00202 *Component Identification System*, and rating plates in accordance with applicable standards.

In particular, the distribution boards shall be provided with a metal plate bearing the assigned information, screwed or riveted on one of the sides.

3.8.6 Electromagnetic Compatibility

The requirements indicated in Chapter 11 shall be fulfilled.

3.8.7 Other Requirements

The necessary devices and measures shall be provided to protect personnel against hazardous voltages. Energised or ‘live’ metal parts and components must be insulated, covered or protected against accidental contact from personnel.

All non-live metal components of the equipment shall be adequately grounded.

All conductors shall be made in electrolytic copper.

All power cables shall be provided with metallic armour (see chapter 8.2).

3.9 REFERENCE DOCUMENTS

The following documents are an integral part of this document:

428-00-R-D-00202	*Component Identification System*
428-00-D-E-40260	*Typical Details of Assembly of Electrical Raceways and Cable Routings*
420-00-I-M-27700	*Painting Specification*

3.10 CE MARKING

All equipment items and complete functional units included in the supply shall feature the corresponding CE marking.

4. MOTOR CONTROL CENTRES AND MISCELLANEOUS PANELS

4.1 MOTOR CONTROL CENTRES

Motor control centres shall be by the same manufacturer as those of the plant and they shall be furnished with the same equipment and components as those supplied for the plant. The Purchaser shall notify the Supplier which manufacturer he should subcontract for the supply of the package plant MCCs. (Nevertheless, from the point of view of bid evaluation, the most important MCC specifications are described below.)

The Supplier shall have the obligation to supply the cubicles and outgoing feeders for the MCCs within its scope that the Purchaser may require for its own use.

4.1.1 Basic Design Requirements

The MCCs will feed three-phase motors with a rated power equal to or less than 75 kW, local panelboards for motor-operated valve actuators and consumers of up to 250 A.

Any actuators not fed from the MCCs shall be subject to Purchaser approval.

The power supply cable to each MCC shall be connected directly to the associated busbar.

In general, the MCCs shall be for indoor installation, appropriate for working properly in the ambient conditions of the rooms where they are housed.

All MCCs shall be sized for at least 120% of maximum continuous current.

4.1.2 Main Technical Characteristics

4.1.2.1 General Characteristics

a)	Manufacturing and testing standards	IEC 60439/60947
b)	Rated service voltage	400 V

c)	Rated insulation voltage	690 V
d)	Rated frequency	50 Hz
e)	Number of phases	3
f)	Power frequency withstand voltage	2500 V
g)	Allowable short-circuit current rms value (1 s)	50 kA
h)	Short-circuit peak withstand current	125 kA
i)	Degree of protection according to IEC 60529	IP42
j)	Contactor control voltage	110 V±10%, 50 Hz

NOTE: The short-circuit level values are preliminary and may be reduced during project development.

4.1.2.2 Contactor Characteristics

All contactors shall be three-phase, air breaking, suitable for industrial service and sized for AC-3 use at rated service voltage.

a)	Manufacturing and testing standards	IEC-60947
b)	Rated voltage	400 V
c)	Rated frequency	50 Hz
d)	Number of poles	3
e)	Utilisation category	AC-3
f)	Rated insulation voltage	690 V
g)	Power frequency withstand voltage	2500 V
h)	Drive coil rated voltage	110 V, 50 Hz
i)	On voltage	85% - 110%
j)	Drop-out voltage	< 70%

Note: In the case of power supply to single phase engines in particular, the contactors shall be of double-pole type

4.1.2.3 Thermal Relays

Contactors shall have differential thermal relays with ambient compensation, and they shall be calibrated according to the specifications of the driven equipment. Reset shall be manual and possible to operate from outside the compartment.

4.1.2.4 Outgoing Feeder Circuit Breakers

a)	Manufacturing and testing standards	IEC-60947
b)	Number of poles	3
c)	Rated insulation voltage	690 V
d)	Power frequency withstand voltage	2500 V
e)	Minimum rated current (“frame size”) in continuous service (considering the maximum temperature inside the MCCs)	100 A
f)	Minimum service short-circuit breaking capacity	50 kA
g)	Minimum short-circuit making capacity	125 kA
h)	Short-circuit power factor	0.25
i)	Protections:	
	- Power supply to motors:	Magnetic
	- Power supply to local panelboards for motor-operated valve actuators and miscellaneous loads (feeders):	Thermal-magnetic

4.1.2.5 Control Voltage Transformers

a)	Transformation ratio	400/110 V
b)	Rated frequency	50 Hz

c) Power As required

They will be designed for continuous operation at 110% of their rated voltage.

Fuses shall be provided in the primary winding and double-pole circuit breakers in the secondary winding to protect the control transformers.

4.1.3 Construction Details

The MCCs shall comprise free-standing independent vertical sections for floor-mounting. The sections shall be screwed together and it shall be possible to extend them at the ends.

They shall be made of steel plate with a minimum thickness of 2 mm, completely closed, with a degree of protection IP42 (for indoor installation) in accordance with IEC 60529.

The vertical sections shall be constructed and compartmentalised in accordance with IEC 60439, form 4b (form 3b optional with price breakdown).

Each outgoing feeder cubicle vertical section shall be divided into the following compartments:

- Equipment compartment, located on the front of the vertical section

  This compartment will comprise physically separated draw-out cubicles with their associated door. Each of the cubicles will house a motor starter or a feeder comprising moulded-case circuit breaker

  Feeders with rated current equal or lower than 32 A are excepted; these shall be frame plug-in circuit breakers that can be grouped on a single panel

- Compartment for connecting exterior cables: located on the back or side of the vertical section and accessible by means of doors or removable panels

- Busbar compartment: located on the upper part of the vertical section

Each MCC shall be provided with a 230 V AC distribution panel fed from the plant's lighting and miscellaneous services power centre, with 15 A double-pole thermal-

magnetic circuit breakers to feed the associated heating circuits, and miscellaneous single-phase loads.

Each MCC shall also be provided with two 100% redundant transformers of the following characteristics: 400/110 V, 50 Hz, voltage to neutral for the control of motor starters, with manual/automatic changeover between both transformers.

An additional transformer of similar characteristics shall be provided for the control voltage power supply with the cubicles in test position.

Starter connection and disconnection commands shall be transmitted directly from the DCS, by means of pulses (voltage-free contacts).

The motor feeder cubicles shall be of the interchangeable draw-out type with test position and mechanical interlock to prevent the door being opened when the circuit breaker is closed. It shall not be possible for the circuit breaker to close if the door is open.

All MCC components shall maintain their ratings at the maximum temperature reached internally at full load.

The MCC busbars shall comprise high-conductivity electrolytic copper strips coated with insulating material, suitable for withstanding the specified short-circuit current. They shall be identified by colours and letters.

Connections between main busbar conductor sections and associated tappings shall be screwed with a minimum of two stainless steel screws, and using tapered washers and other suitable means to prevent a reduction in contact pressure between conductors.

Connections between busbars shall be silver-plated.

Busbar supports and spacers shall be made of epoxy resin insulating material.

MCCs shall be furnished along their entire length with a copper grounding busbar with tappings to each of the vertical sections, and all non-current carrying metal parts shall be electrically connected to it.

At both ends of the MCC grounding busbar there shall be a clip-on grounding terminal which shall be fixed with a minimum of two screws and suitable for connecting a 185 mm^2 copper earth wire.

All paint shall be removed from areas where the grounding busbar connects to the panel structure in order to obtain good electrical contact.

The grounding busbar shall be equipped with tappings that extend to the cable compartment to enable connection of the earth conductor included in the power supply cable to the equipment, if required in accordance with that established in Chapter 9 of this document.

Power and control cables shall always enter through the bottom part.

All components housed both inside and outside the panels shall be furnished with an identification plate bearing the information that each one has in the electrical drawings.

The identification plates shall be of white laminated plastic with engraved black lettering and they shall be fixed by screws.

The terminal blocks to be used shall be of Faston type (clips) or pressure type by spring connection.

Flexible, electrolytic copper wire shall be used for internal wiring, and it shall be capable of withstanding a 3000 V dielectric strength test, flame-retardant in accordance with IEC 60332-1 and IEC 60332-3 category C, and free of halogens (IEC 60754-1).

The following are the minimum cross-sections allowed:

- Power and current circuits: 2.5 mm^2
- Voltage and control circuits: 1.5 mm^2

The colour code for internal wiring insulation shall be as follows:

- Black, when only one colour is used

- Brown, when an additional colour is used

No more than two conductors or wires shall ever be connected to the same side of a terminal block.

Terminal blocks comprising more than one deck shall not be allowed.

Current transformer secondary circuits shall include short-circuitable terminals.

Conductor identification shall include the cable number, the wire number and the terminal number.

4.1.4 Equipment

Incoming feeders: 400/110 V, 30 VA, class 1 voltage transformer protected with fuses in the primary winding, voltmeter and undervoltage relay. Relay contacts shall be wired to terminals for remote signalling.

Outgoing feeder lines: frame plug-in moulded-case circuit breaker with thermal-magnetic protection.

MCC motor starters shall comprise a circuit breaker with magnetic relay - contactor - differential thermal relay with manual reset - three signalling LEDs (on / off / overload).

The single phase motor starters shall be of double-pole type, and shall be powered through a 400/230 V transformer with adequate power to be installed in a specific compartment.

Feeder line circuit breakers shall have at least one auxiliary changeover contact wired to terminals for remote signals.

Starter cubicles shall be equipped with the following local LEDs:

- On (red)
- Off (green)

- Thermal relay trip (blue)

For remote signals, the following potential free auxiliary contacts shall be wired to terminals:

- Contactor auxiliary contacts (1NO + 1NC)
- An auxiliary changeover contact for each feeder circuit breaker. They shall be grouped to give a common signal
- An auxiliary (1 NO) contact of relay 74 for “cubicle not available”

If other local or remote signals are considered necessary, they shall be defined during the MCC purchase procedure.

The motor control centres shall be wired using the same power and control typical drawings as those used for the plant motor control centres. Such drawings will be given to the Supplier during the purchase process.

Cabinets and cubicles shall be provided with the associated KKS code nameplates to be agreed upon award of contract.

Each MCC shall be provided with the following reserve cubicles:

- 20% empty (without equipment)
- 10% equipped, of which 60% will be power supplies to motors and 40% feeder lines

All package plant MCCs shall have one equipped reserve cubicle of each type as a minimum.

4.1.5 Tests

The MCCs shall be subjected to the routine shop tests set out in Section 8 of IEC-60439.

The Supplier shall submit type test protocols, in accordance with said standard, carried out on identical or similar equipment to those supplied.

Similarly, an Electromagnetic Compatibility Compliance Certificate for emission and immunity shall be submitted in accordance with European Directive 89/336/EEC.

Individual component testing shall not be required from the Supplier for the equipment covered by this specification. It will be sufficient for him to provide type and routine test protocols or certification for said components in accordance with applicable IEC standards.

Onsite tests shall include, in addition to insulation resistance measurement and verification of alarms and trips, the functional and global test to be performed for each MCC supplied, including all the cubicles.

4.2 MISCELLANEOUS PANELS

4.2.1 General Characteristics

The low voltage miscellaneous panels shall be designed for rated voltage of at least 500 V and shall comply with IEC Standard 60439.

Panels shall be sized to withstand at least 120% maximum continuous current.

Power supply for the panels shall be through an on-load manual switch.

The incoming circuit-breakers shall be moulded case in accordance with IEC 60947-2 with thermal-magnetic protection and sufficient breaking capacity. The breaking capacity required will be defined in a later phase of the project. The outgoing breakers shall be miniature circuit breakers (MCB) type for breaker capacity equal or less than 25 kA and moulded case circuit breaker (MCCB) for breaker capacity higher than 25 kA. Circuit breakers shall be provided with at least one changeover auxiliary contact hardwired to terminals for trip remote signalling. Contacts shall be grouped to provide a common signal.

The circuit-breakers shall be manually operated with trip-free quick-connect-and-disconnect mechanism.

The position of the control handle shall clearly and unmistakably show the position of the circuit breaker, indicating whether it is closed, open or automatically tripped.

The busbars shall be made up of high conductivity electrolytic copper strips coated with insulating material.

The connections between the sections of the main busbar conductors and its derivations shall be bolted at least in two locations, using tapered type washers and other appropriate means to prevent any reduction in contact pressure between conductors. The contact surfaces must be silver-plated.

Supports and bus spacers shall be made from epoxy resin insulating material.

Panels shall be made of steel plate no less than 2 mm thick or compressed polyester (in this case, the equipment shall be totally coated with insulation material and the parts under voltage shall never be placed outside the casing and no metallic component may cross it).

Panel fronts shall be accessible by means of doors with locking system and may comprise one or more sections, depending on the size of the panel.

The locking system consists of a door lock latching onto the fixed part. The key must be submitted to the Purchaser's approval. However, preference is given to the "Ronis" type, and keys with code 455 shall not be used.

Panel backs shall comprise doors with locks or removable metal panels, with gaskets on the borders.

Suitable drill holes shall be made in the bottom of the panels designed for floor mounting so that they can be fixed with bolts supplied by the Purchaser, but the diameter of the bolts shall be defined by the Supplier.

Rectangular gaps shall be left at the bottom for the insertion of cables which will be covered by plates screwed to the inside of the panel floor, taking care to ensure that they are as vertical to the terminal blocks as possible.

The panel shall be equipped with 230 V single-phase space heaters to prevent condensation forming inside. They shall be controlled by an relativity humidity actuator and protected by a circuit breaker installed inside the panel.

Lamps shall be fitted in the top part to provide light inside the panel, fed from a single phase 230 Vac supply. A switch will be fitted in each panel section to control the associated lamps.

Inside the panel a grounding busbar shall be installed vertically along one side.

In panels comprising several sections, grounding busbars shall be installed horizontally along them.

All paint shall be removed from areas where the grounding busbar connects to the panel structure in order to obtain good electrical contact.

Connections between grounding busbar sections shall be made with at least two screws.

At both ends of the panel grounding busbar there shall be a clip-on grounding terminal which shall be fixed with a minimum of two screws and suitable for connecting a 95 mm^2 copper earth wire.

The panel shall be delivered completely wired to terminal blocks for external connection.

The terminal blocks to be used shall be of Fuston type (clips) or pressure type by spring connection.

Flexible, electrolytic copper wire shall be used for internal wiring, and it shall be capable of withstanding a 3000 V dielectric strength test, flame-retardant in accordance with IEC 60332-1 and IEC 60332-3 category C, and free of halogens (IEC 60754-1).

The following are the minimum cross-sections allowed:

- Power and current circuits: 2.5 mm^2
- Voltage and control circuits: 1.5 mm^2

The colour code used for internal wiring insulation shall be as follows:

- Black, when only one colour is used
- Brown, when an additional colour is used

No more than two conductors or wires shall ever be connected to the same side of a terminal block.

Terminal blocks comprising more than one deck shall not be allowed.

Conductor identification shall include the cable number, the wire number and the terminal number.

All cable ends shall be identified with plastic rings bearing indelible inscriptions. Lettering on adhesive tape shall not be allowed.

All components housed both inside and outside the panels shall be furnished with an identification plate bearing the information that each one has in the electrical drawings.

The identification plates shall be of white laminated plastic with engraved black lettering and they shall be fixed by screws.

Minimum degree of protection class shall be IP42 (indoor) and IP54 (outdoor), in accordance with IEC 60529.

4.2.2 Shop Testing

The panels shall be subjected to routine shop tests set out in Section 8 of Standard IEC-60439.

The Supplier shall submit type test protocols, in accordance with said standard carried out on identical or similar equipment as those covered by this document.

Similarly, an Electromagnetic Compatibility Compliance Certificate for emission and immunity shall be submitted in accordance with European Directive 89/336/EEC.

Individual component testing shall not be required from the Supplier for the equipment covered by this Specification. It will be sufficient for him to provide type and routine test protocols or certification for said components in accordance with applicable IEC standards.

Onsite testing shall include, in addition to the insulation resistance measurement and verification of alarms and trips, the functional and global test to be performed for each panel supplied.

5. MEDIUM VOLTAGE MOTORS

See the Technical Specification for MV Motors, Document No. 428-00-I-E-20320.

6. LOW VOLTAGE MOTORS

6.1 BASIC DESIGN REQUIREMENTS

Unless otherwise stated, LV motors shall be 400 V AC, induction type with squirrel cage rotor, air-cooled by means of fans installed on the shaft, constant speed and direct on-line starting at full voltage.

The winding shall be star-connected.

The rated power of the motors shall be defined by the manufacturer of the driven equipment. To determine the useful power to be supplied by the LV motors, the following principles should be taken into account:

- Reserve a minimum useful power excess of 10% in the shaft, relating to the continuous power necessary to drive the respective equipment
- Achieve smooth running of the output curve and of the power factor in a range between 75% and 100% of the nominal power

Motors shall be insulation class F or higher, but with temperature rise limited to those of insulation class B.

Motors shall comply with Standard IEC-60034 and, with the exception of motors for actuation of cranes, lifts or similar equipment, shall be sized for rated power in S1 type continuous duty, in accordance with IEC 60034-1.

Intermittent duty motors shall be designed for the type of duty required by the equipment driven in compliance with Standard IEC 60034-1.

Rated voltages shall be as follows:

- Motors > 0.5 kW and ≤ 200 kW: 400 V, 3 phases, 50 Hz
- Motors ≤ 0.5 kW: 400 V, 3 phases, 50 Hz or
  230 V, phase and neutral, 50 Hz

All motors shall have capacity for the successive starts necessary to cover all operating modes to which they may be subjected. As a minimum they shall have capacity for two successive hot starts and three consecutive cold starts.

The indicated starting frequency lasts one hour, including the possibility of successive starting cycles and of periodic intermittent cycles, as indicated, without the stator winding temperature rise exceeding 105ºC in the environmental conditions laid out.

A successive startup cycle must be understood as a cycle initiated with the motor stopped, full or partial start, followed by a power cut and a start after a speed reduction, complete or not, in which the driven organ is under load during speed reduction and recovery.

All motors shall be capable of starting up and accelerating their load with a voltage value in motor terminals equal to or higher than 80% of the rated voltage.

Motors shall be able to maintain their operating stability at full load, for reduced voltage values of up to 75% for 5 minutes and 70% for 2 minutes. The expected resulting temperature rise of this operation must not damage the motor.

The pull-up torque value of the motor shall comply with Standard IEC 60034-1 and 60034-12.

The breakdown torque value at rated voltage and frequency shall not be less than 2.1 times the rated torque value of the motor.

The difference between the motor torque developed during the acceleration period at minimum startup voltage and the brake torque of the driven equipment shall be at least 10% of motor rated torque, at any speed between zero and breakdown torque speed of the motor.

The locked rotor torque of the motor at the rated voltage and frequency shall not be less than 1.6 times the maximum resistive startup torque of the driven equipment item.

The maximum locked-rotor current at rated voltage and frequency shall be equal or lower than 6 times the rated current as per IEC 60034.

The maximum allowable time with the rotor locked shall be not less than 1,25% of the starting time at rated voltage and at 80% of rated voltage, with rated frequency and rated load, taking into account driven equipment inertia.

The sound pressure level radiated by the motors shall not exceed 80 dB(A) at a distance of one (1) metre. Furthermore, the motor sound requirements shall be in compliance with NP-1733 *Estímativa de protecção do ruido durante o exercísio de una actividade profissional com vista à protecção do audição* and with DL292/2000 *General Noise Regulations*.

Motors shall be designed so that, once the starting period is over, they can operate satisfactorily with supply voltage and frequency values according to IEC 60034 between the following limits:

- ±10% of rated voltage
- +2%, -3% of rated frequency

Motors shall be designed to withstand the residual field voltage at 40% with opposite phase angle, during motor restart at rated voltage.

The direction of rotation shall be established by the manufacturer of the driven equipment. It shall be defined as clockwise (CW) or counter-clockwise (CCW) when loocking at the motor from the side opposite the coupling.

The direction of rotation shall be indicated permanently on the motor enclosure unless the operated equipment makes it necessary to find another location for said indication. If motors have two shafts, the aforementioned rule applies to the end with the greatest power.

All LV motors of the same type, power, speed and direction of rotation shall be interchangeable, unless otherwise indicated to facilitate assembly (eg, mirror slabs).

Interchangeability must be ensured to guarantee equality between shaft heights and the fastening height levels.

Motors and complete functional units shall be provided with their corresponding CE marking.

The motors shall be designed to withstand overspeed values indicated in IEC60034-1 with a minimum of 20% without mechanical breakdown. They shall also be designed to comply with the requirements of level "R" established in IEC 60034-14 "Mechanical Vibrations". For cases that are not envisaged in the IEC 60034-14 standard, the most demanding standard of VDE 2056 or NEMA MG-1 shall be applied.

In order to check axial and radial vibrations, bearings shall be equipped with one (1) appropriate adaptor permitting fast connection to the respective measuring device.

Motor roller or ball bearings shall have a rated L_{10} life of 80,000 hours and an average L_{50} life of 200,000 hours' continuous duty at motor full-load speed, subjected to the radial loads and sustained axial thrusts specified, in ambient conditions corresponding to the area of installation and operating requirements of the motor in question.

Vertical shaft motors which are not provided with a device to prevent the reversal of the turning direction shall be designed in such a way that, in the event of pump turbinisation upon disconnection of the motor from its power supply, they shall be capable of withstanding turning in the opposite direction to that of normal operation, without mechanical breakdown.

Vertical motors, where indicated by the Supplier of the equipment driven, shall be designed to withstand the thrust of the equipment driven. Thrust values shall be defined by the Supplier of the equipment driven.

Coordination with the motor manufacturer for coupling machining and supply shall be the responsibility of the driven equipment supplier, considering the shaft end dimensions of both pieces of equipment.

The coupling with the operated machine shall be protected to prevent accidental contact.

The motor rotors shall be suitably balanced, statically and dynamically, so as to ensure that the rotation movements on the supports are produced without the action of centrifugal balancing forces.

The quality of the balancing rating shall be at least equal to rating G6.3 of ISO 1940 (Table 1). Likewise, the specific residual unbalance shall comply with that allowed for rating G6.3 of the same standard.

6.2 MANUFACTURE DETAILS

Motors whose rated power is greater than 55 kW shall be equipped with protected space heaters that will start operating when the motor is out of service and maintain motor temperature 5ºC above ambient temperature in order to prevent internal moisture condensation. The space heaters shall be supplied at 230 V, single phase and neutral, 50 Hz.

Motors shall be equipped with three terminal boxes of sufficient size and provided with suitable terminals for the following services: one of them shall receive the connection of the power cables, another one for the cables for the space heaters and the third one for instrumentation cables (Pt-100) for motors P > 75 kW and thermocouples PTC for motors with rated power 18.5 ≤ P ≤ 75 kW.

The design of the terminal boxes shall be such that they shall be able to rotate 360º in 90º steps.

The terminal boxes shall be fitted with an internal grounding terminal.

Motors rated > 75 kW must be equipped with six (6) Pt-100 resistance temperature detectors (RTD) in the stator windings (two per phase). They shall also include two other double Pt-100 resistance temperature detectors (RTD), one in each bearing. Pt-100 RTDs shall be three-wire.

Thermistors (six PTC-type sensors) will be installed in motors rated from 18.5 to 75 kW, unless they are located in a conditioned atmosphere.

The frames of motors with power greater than 75 kW shall be provided with two (2) clamp-type terminals, located diametrically opposite, adequate for the connection of a copper earthing conductor with a section of 185 mm^2.

The frames of motors with power greater than 18.5 kW and equal or lower than 75 kW shall be equipped with one (1) clamp-type terminal that shall be adequate for the connection of a copper earthing conductor with a section of 95 mm^2.

The power terminal boxes for motors with a rated power ≤ 18.5 kW shall be fitted with an internal grounding terminal suitable for the earthing conductor cross-section. The motor shall be grounded by the earth wire built into the power cable.

The motor terminals for connection of power cables, and the size of the power terminal box and its removable cover shall be suitable for cables with the following cross-sections and their associated cable glands:

Output (kW)	Cross-Section (mm^2) (1)
2	4 x 6
2.2	4 x 6
3.7	4 x 6
5.5	4 x 6
7.5	4 x 16
11	4 x 16
15	3.5 x 25
18.5	3.5 x 25
22	3 x 50
30	3 x 50
37	3 x 70
45	3 x 70
55	3 x 95
75	3 x 150
90	3 x 150
110	3 x 1 x 300 (2)
125	3 x 1 x 300 (2)
140	3 x 1 x 400 (2)
160	3 x 1 x 400 (2)
200	3 x 1 x 400 (2)

(1) The sections indicated are tentative. The final cross-section of the cables supplied by the vendor to be used in each case shall be determined by the Supplier.
(2) When more than one ternary of cables is required because of the distance between the motors and the power source, it may be necessary to use junction boxes to reduce the cross section.

Terminal boxes shall have blank removable aluminium covers for subsequent machining of the necessary orifices at the equipment erection stage.

All motor terminal boxes shall be designed to withstand short-circuit current for 0.3 s, with a maximum short-circuit current of 50 kA (symmetrical) and 125 kA (peak).

All motor shall be totally enclosed. The degree of protection for indoor and outdoor motor casings shall be IP-55 in accordance with IEC-60034-5. Terminal boxes shall have a degree of protection IP-55.

Motors that may be subject to immersion shall comply with degree of protection IP-58 in accordance with IEC 60034-5.

All motors that weigh more than 25 kg shall be equipped with lifting lugs.

Motors shall be designed for a minimum life of 25 years.

Motors shall be built to withstand 4-month shutdowns without control or any type of precaution prior to restart.

Motor windings and their insulation must withstand mechanical shocks from consecutive starts and power source swings.

Motors shall be provided with a stainless steel rating plate, written in Portuguese, bolted to the casing, containing at least the information indicated in IEC Standard 60034-1, including the lubrication grease or oil used in the bearings.

For motors that will operate in particularly dusty locations, that are subject to oil spills and abnormal accumulations of dirt (to be indicated by Supplier), a label containing the same type of information shall be placed on the inner side of the lid of the instrumentation terminal box.

In addition to the above, there will be a second nameplate, in a clearly visible location, with the motor identification according to the KKS Code.

6.3 TESTS

6.3.1 Routine Tests

All motors shall be submitted to the following shop tests:

a) No-load test, with measurement of iron losses and of the no-load current, as per IEEE-112

b) Locked rotor test as per IEEE-112. If the test is carried out at a reduced voltage, a measurement of the motor starting current at rated voltage and the frequency shall be provided

c) Power frequency withstand test for one minute, as per IEC 60034-15

d) Measurement of insulation resistances before and after the dielectric test, as per IEEE-112

e) Measurement of winding resistances, as per IEEE-112

f) Direction of rotation and phase sequence, as per IEC 60034-8

g) Measurement of vibrations and rotor balance, as per IEC 60034-14

h) Dimensional check and verification of finish

i) Inspection of the motor auxiliary device wiring

j) Determination of the magnetic centring

k) Operating inspection of the RTDs of windings and bearing

l) Measurement and verification of current symmetry on the three (3) phases

m) Overspeed test, as per IEC 60034-1 (optional with price breakdown)

6.3.2 Type Tests

The following type tests shall be performed for all motors under 55 kW:

a) Noise level measurement at a distance of 1 m, as per IEC 60034-9

b) Determination of losses, efficiency and power factor at 25, 50, 75 and 100% of full load, as per IEC 60034-2

c) Establishment of the speed-torque, speed-current and speed-power factor curves, as per IEEE-112

d) Temperature rise test, as per IEEE-112

e) Off-load and short-circuit test

f) Measurement of the gap in cold conditions and after the warm-up test at nominal load

g) Determination of the moment of inertia

For motors under 22 kW, the following tests shall be performed:

a) Verification of the heating and cooling time constants

b) Verification of the time constants of components and of the voltage and current in off-load conditions

c) Determination of the X/R ratio

Performance of the type tests may be replaced by type test certificates for motors of the same type.

6.3.3 Site Verifications and Tests

The following verifications and tests shall be performed at the site under the supervision of the Supplier:

a) Verification of the list of all materials

b) Verification of the complete connection of all the accessories and power, control, signalling and protection circuits, in accordance with the drawings

c) Verification of the nominal characteristics marked in the identification plate

d) Verification of correct operation of all the auxiliary and protection devices (if any)

e) Determination of the insulation resistance of the stator windings and auxiliary equipment (Megger of 500 V for 1 minute)

f) Verification of the free flow of fresh air intake and hot air outlet

g) Alignment measurement of the semi-coupling between the motor and the operated machine

h) Vibration measurement

i) Startup current measurement and checking the motor's capacity to support the startup frequencies guaranteed

j) Measurement of the current and power factor with service load under rated voltage

k) Measurement of the stator heating through temperature sensors

l) Verification of the operation of the temperature sensors for the specified values (if any)

m) Verification of the functionality of the motor with the activated equipment and with the electric and thermal protection system

n) Verification of motor instrumentation

o) Verification of the operation of the heating (if any)

7. ELECTRIC MOTOR-OPERATED VALVE ACTUATORS

7.1 BASIC DESIGN REQUIREMENTS

Unless otherwise indicated, motors for valve actuators shall be alternating current (ac), three-phase, induction type with squirrel-cage rotors, designed for S2 short-time duty as defined in IEC 60034-1, with a rated duty time of 10 minutes.

Where data sheets request actuators according to a particular manufacturer's type and model, equivalent models made by other acceptable manufacturers may be proposed but, as a general rule, the aim will be to provide those specifically requested in the data sheets.

Electric actuators shall be suitable for a power supply of 400 V, 3 phase, 50 Hz. Voltage and frequency may vary as per IEC 60034 by ±10% and +2%, -3% respectively. Minimum operating voltage at actuator terminals shall be 80%. They shall be fitted with motor starter-inverter contactors, thermal protection relays and an integrated local pushbutton box with open/close pushbuttons and local/stop/remote selector. Similarly, they shall incorporate a terminal block for connection of power cables and all control signals. It shall be possible to adjust torque and limit switches without removing the covers of the electrical compartments. The degree of protection shall be IP-67.

The actuator shall incorporate an internal grounding terminal suitable for the earth conductor cross-section. Grounding shall be via the earth wire built into the power cable.

Given the short-time duty of the actuator, it will be equipped with 230 V, 1 phase and neutral, 50 Hz space heater.

The actuator shall be designed to ensure valve closure against the design maximum differential pressure, and valid for any assembly position.

The starter contactor equipment and actuator shall be capable of operating with voltages between 80% and 110% of the rated voltage. The drop out voltage shall not exceed 70% of the rated voltage.

The starter contactor equipment and the thermal relays shall be defined based on the following:

- Rated current
- Locked rotor current
- Service time with locked rotor (maximum 10 seconds)
- Rated duty time, 10 minutes

The following motor protections will be provided:

- The motor shall disconnect automatically if the valve sticks when it is unseating
- A thermostat shall be provided for motor disconnection in case of overheating
- The motor shall be disconnected in case of loss of one phase

7.2 MANUFACTURE DETAILS

The electric motor shall have Class F insulation and shall be capable of continuous operation at one third of its rated load, starting with an ambient temperature of 40°C, during 15 minutes or twice the time of operation of the valve, whichever is longest.

For emergency operation, a handwheel shall be provided which shall be engaged by means of a lever or similar device. The motor drive shall be automatically re-established when it is energised but under no circumstances shall it cause the handwheel to turn. The clutch can be padlocked in manual or automatic position.

The design of the actuator-valve coupling shall make it possible to disassemble the actuator without removing the valve bonnet.

The Supplier shall point out any restriction relating to valve or valve stem orientation in his proposal. Whenever possible, the valve-actuator assembly shall be able to be placed in any position.

Each valve will receive a maintained order for opening and closing. This order will be a dry contact from the DCS, powered from the actuator itself with 110 VAC. The order will disappear once the valve has reached the demanded position.

The valve will give as well two dry contacts as feedbacks of "Valve Open" and "Valve Closed", powered from the DCS with 48 VDC.

In addition, each actuator shall be equipped with two independently-adjustable torque limit switches dependent on the turning moment, one for the “open” direction and another for the “close” direction. The control valves operated by means of electrical actuators shall have position transmitters of 4-20 mA.

For local indication of valve position, the actuator shall be equipped with a display showing the percentage position in increments of 1%. In addition, there shall be colour-coded lamps to show position. The percentage indication shall continue even if the power supply is disconnected.

The actuator shall have an integrated control station for local opening, closing and stopping operations. There shall be a local/stop/remote selector which can be padlocked in the three following positions:

- Local control only
- Stop (electric operation disabled)
- Remote control with possibility of local stop

It shall be possible to select local control to be maintained or pulsated.

The operation of local controls shall allow valve movement to be reversed without having to stop the actuator.

All actuators shall have a wide power margin in order to position the valve under any of the operating conditions specified in the data sheets. Motor rated output shall be designed for a duty-cycle rating of 10 minutes in accordance with Standard IEC 60034-1 *Short-Time Duty Motors.* During this maximum operation time, the acceptable temperature limits of the motor insulating system shall not be exceeded. Motors shall be sized as a minimum according to the requirements of shaft brake torque and valve duty time required.

The actuator shall include the following devices as a minimum:

- Hammer blow device
- Self-locking device which will lock the valve in position in case of power failure

Where determined by the valve manufacturer, due to high inertia of the actuator during its closing manoeuvre which can cause strains in the valve seat, a device should be provided to absorb the kinetic energy of the actuator in order to limit the torque to a value which the valve seat can withstand.

Similarly, it will also be acceptable, as an alternative, to have an adjustable brake system to carry out this function.

The identification of each actuator shall be shown on a bolted stainless steel plate. This identification shall include the information set out in IEC 60034-1 as a minimum requirement. It will also include the valve identification number (KKS), opening and closing times, and maximum differential pressure of the valve (shut-off).

7.3 TESTS

Shop tests to be carried out on the motors (actuators) shall be routine tests required by Publication IEC-60034.

Shop testing to be performed on the assembly of motor-contactor starter inverter, thermal relays, actuator switches, wiring, etc, shall be the routine ones required by the relevant IEC standard and the following shall be performed as a minimum:

- Wiring check
- Dielectric strength test at power frequency
- Insulation resistance measurement
- Operational check

Certification shall be supplied for type tests performed on the same kind or similar motor actuators and their starter equipment as required in the scope of supply, as well as for routine tests performed on the motor-actuator-starter equipment assembly.

8. CABLES

8.1 GENERAL CHARACTERISTICS

Low voltage power, control and instrumentation cables shall be designed for fixed installation in trays, in steel tubes, in air and in underground PVC ducts embedded in concrete.

All cables shall withstand flame-retardant tests in accordance with IEC-60332.1 in the case of individual conductor or cable, and IEC 60332.3 category C in the case of cables arranged in layers.

Control and instrumentation cables shall be free of halogens (IEC 60754-1) with reduced smoke emission during combustion (IEC 61034) and have a low corrosion index (IEC 60754-2).

All cables shall be identified on the sheath with the manufacturer's name, cable type, number of conductors and cross-section, and rated insulation voltage, as a minimum.

Cables shall preferably be from the same manufacturer and with identical characteristics as the plant cables. In any case, the cables must be manufactured by one of the qualified manufacturers indicated in Appendix F.

In the absence of the corresponding IEC standard, application of the Portuguese standards (NP) and regulations shall be compulsory.

8.2 LOW VOLTAGE POWER CABLES

Low voltage power cables shall have a rated insulation voltage of 0.6/1 kV, XLPE insulation and black sheath made of modified polyolefin (Z1, halogen-free) which guarantees flame retardant properties.

For multi-core cables, empty spaces should be filled with halogen-free fire-retardant materials to standardise the whole set.

Low voltage cables shall be provided with metallic armour. However, LV cables for lighting systems shall not be armoured The metallic armour is not required for LV

process cables installed indoors (between nearby process switchboards) and internal switchboard cabling.

Conductors shall be compact round cord-type formed by annealed copper strands, whose characteristics shall comply with the requirements for class 2 conductors established in IEC 60228.

Cables shall be single-core for sections greater than 240 mm^2 and multiple core for equal or smaller sections.

The minimum cross-section shall be 2.5 mm^2 for overhead installation and 6 mm^2 for underground installation.

The maximum allowable voltage drop in cables shall be 2.5% in continuous operation and 10% in startup (in the case of motors).

To size cables for allowable current, consideration must be given to correction factors for temperature, type of installation, and number and layout of cables in the raceways. An overall factor of 0.6 applied to the admissible current of cables in air at 40ºC may be used, granted the cables do not run through underground pipes embedded in concrete. The use of higher factors shall make approval by the Purchaser necessary.

Cables that feed motors shall be sized for at least 125% of their rated current.

All power cables shall be designed for a maximum service temperature of 90ºC.

8.3 CONTROL CABLES

Control cables shall be multi-core and shall have a rated insulation voltage of 450/750 V, XLPE insulation and blue modified polyolefin sheath (free of halogens) which guarantees flame retardant properties. Cables shall comply with IEC 60245.

Conductors shall be of compact round cord type formed by annealed copper strands, whose characteristics shall comply with the requirements conductors, established in IEC 60228.

The minimum cross-section shall be 2.5 mm^2.

The minimum cross-section of the conductor shall be 6 mm^2 and 4 mm^2, respectively, for current and voltage circuit cables.

8.4 INSTRUMENTATION CABLES

Instrumentation cables shall have a rated insulation voltage of 300/500 V, XLPE insulation and grey modified polyolefin sheath (halogen-free) which guarantees flame retardant properties. Cables shall comply with standard HD627 S1.

Conductors shall be flexible copper cords, according to IEC 60228.

Instrumentation cables shall in any event comply with the requirements of the manufacturer of the instruments to which they are connected.

In places where temperatures may exceed 250ºC, the compensation cables for measuring the temperature shall have mineral insulation.

The cross-section shall be 0.5 mm^2 in the case of multiconductor cables, and 0.75 mm^2 in the case of multiple pair or multiple ternary cables.

Analogue and digital signals shall not be carried by the same cable.

8.4.1 Makeup of the Cable and Shield

a) Multiconductor cables

Insulated conductors shall be wired together in accordance with part 7, section M of HD627 S1.

Wired conductors shall have an overall shield and drain wire in accordance with the above-mentioned standard (a reinforced overall shield is not required).

b) Multiple pair cables and multiple ternary cables for RTDs

The conductors in each pair or ternary shall be twisted to minimise the signal errors induced by conductors comprising the same cable.

The makeup of the cable in respect of conductors, individual shield and drain wire, overall shield and drain wire (a reinforced overall shield is not required) shall be in accordance with part 7, section M of HD627 S1.

8.5 CABLE IDENTIFICATION

The equipment or package plant supplier shall take the following points into consideration when defining cables within his scope of supply:

1) The reference of each cable type to be supplied must coincide with the reference of the cables for the BOP (indicated to the Supplier in the kick-off meeting)

2) Identification of cables by colour code (both for the associated sheath and for the conductors). Consideration shall be given to that indicated in the following tables, which shall in turn be applicable to all BOP cables.

IDENTIFICATION COLOUR CODES FOR CABLES AND CONDUCTORS

TYPE		SHEATH	INSULATION		DRAWING IDENTIFICATION
			Manufacture	Identification	
MEDIUM VOLTAGE CABLES	THREE-CORE	Red	Conductor No: 1 2 3	Colour: R - Brown S - Black T - Grey Shield	 N K G S
	SINGLE-CORE		Natural	By colour marks on each phase. (Same colour code employed for three-core cables)	
LOW VOLTAGE CABLES	MULTIPLE CORE	Black	Conductor No.: Four-core 1 2 3 4 Three-core 1 2 3 Two-core 1 2	Colour: (1) R - Brown S - Black T - Grey R - Brown S - Black T - Grey Neutral or – Light blue Phase or + Brown	 (1) N K G N K G B N
	SINGLE CORE		Natural	By colour marks on each phase. (Same colour code employed for multiple core cables)	
CONTROL CABLES		Blue	Black	White numbers	Numerical
INSTRUMENTATION CABLES	MULTICONDUCTOR	Grey	Black	White numbers	Numerical
	PAIRS AND TERNARIES		Pair/Ternary No.	Colour (see Table 1 attached)	See Table 1 attached
	MULTIPLE PAIRS/ TERNARIES				
THERMOCOUPLE EXTENSION CABLES	K TYPE (Chromel alumel)	Yellow	Identification of each pair by numbered tape	Yellow (+) Red (-) Shield	eg, two pairs: 1Y+, 1R–, S1 | S 2Y+, 2R–, S2 S1, S2, ... Sn ⇒ shield of each pair S ⇒ cable shield
	E TYPE (Chromel constantan)	Violet	Identification of each pair by numbered tape	Violet (+) Red (-) Shield	V + | R – | S S1 | S1, S2, ... Sn ⇒ shield of each pair S ⇒ cable shield

(1) This colour will be:

If neutral	Light blue	B
If earth	Yellow/Green	L

IDENTIFICATION COLOUR CODE FOR CABLES AND CONDUCTORS						
Table 1						
PAIR/ TERNARY No.	COLOUR OF INSULATION (*)			IDENTIFICATION FOR DRAWINGS (**)	SHIELDS	
	Conductor a	Conductor b	Conductor c		PAIR/TERNARY	CABLE
1	White	Blue	Violet	1W, 1B, 1V	S1	S
2	White	Orange	Violet	2W, 2A, 2V	S2	
3	White	Green	Violet	3W, 3E, 3V	S3	
4	White	Brown	Violet	4W, 4N, 4V	S4	
5	White	Grey	Violet	5W, 5G, 5V	S5	
6	Red	Blue	Violet	6R, 6B, 6V	S6	
7	Red	Orange		7R, 7A	S7	
8	Red	Green		8R, 8E	S8	
9	Red	Brown		9R, 9N	S9	

(*) The colours indicated for Conductor **a** and Conductor **b** shall be used in multiple pair cables
The colours indicated for Conductor **a**, Conductor **b** and Conductor **c** shall be used in multiple ternary cables

(**) For pairs, only the first two alphanumerical groups indicated for each pair shall be used

Only combinations for cables of up to 9 pairs and 6 ternaries have been indicated.

Following the criterion established in the plant, suppliers of mechanical equipment or package plants shall submit for approval a document including the different types of cables to be used -identified by references- and their characteristics (composition, outside diameter, weight in grams/metre, sheath colour, etc).

In the electrical wiring diagrams, once the wires have been grouped to form the cables, the cables shall be identified with a code (KKS) like the one used for the BOP cables. The identification code and method to be used for wiring between equipment is indicated in Document no. 428-00-R-D-00202, *Component Identification System*.

Cables shall be identified throughout their run as follows:

- Labels on both ends
- A label every fifteen metres on straight sections and at each fork in every cable tray run
- A label at each conduit inlet or outlet

In addition to indicating the aforementioned identifications on the outer cable sheath, the following information shall be indicated clearly and indelibly at every metre of cable:

- Manufacturer
- Design and manufacturing standard
- Number of conductors x gauge
- Voltage (U_0/U kV)
- Product batch
- Year of manufacture
- Meter number indicated on the outer cable sheath

The same type of marking (FERRULED) shall be used for the connection of cable conductors as that established for all the BOP cables. The procedure shall be agreed with the plant erection management.

The requirements and criteria indicated in drawing No. 428-00-D-E-40260, *Typical Details for the Assembly of Electrical Raceways and Cable Runs* shall be taken into consideration for the installation of cables, trays and conduits.

9. GROUNDING

Metal structures and non-current-carrying metal equipment parts shall be connected to the grounding network.

Equipment and components shall be connected to the grounding network by means of pressure clamps. Structures shall be connected by means of aluminothermic welds adapted to each type of connection.

Bare copper cable of the following cross-sections shall be used for grounding:

- Steel structures and mechanical equipment (pipes, tanks, platforms, gratings, plates, etc) 35 mm^2
- Motors with a power rating of more than 18.5 kW and less than or equal to 75 kW, and miscellaneous panels 95 mm^2
- Motors with a power rating of more than 75 kW and MCCs (two ground clamps) 185 mm^2

Motors with a power rating equal to or less than 18.5 kW shall be grounded by the earth wire built into the power cable whose cross-section shall be that indicated in section 6.2 of this document.

Likewise, motor-operated valve actuators and three-phase loads whose continuous consumption is equal to or less than 32 A shall be grounded by the earth wire built into the power cable. Cables with four (4) conductors with the same cross sections shall be used for cross-sections up to 16 mm^2 and with 3.5 conductors for bigger cross-sections. The earth wire shall be connected to the grounding terminal or strip housed inside the equipment.

10. CABLE RACEWAYS

The following types of raceways can be used for cable distribution: cable trays, steel conduits exposed/embedded in concrete and PVC duct banks.

Exceptionally, and after a special authorisation is sent by the Purchaser, the existing raceways of the plant (long routing and road crossings) may be used.

Separate ladder type cable trays (or other type) shall be supplied for different services as set out below:

- Trays for low voltage power and control cables, designation “B”
- Trays for instrumentation cables (<60 V), designation “Y”

In layouts where trays placed on top of one another, the highest voltage cable tray shall be placed at the top and the lowest voltage tray at the bottom.

For all trays, installed inside or outside, covers shall be provided on the top tray for mechanical protection.

Cable trays shall be made of steel with hot-dip galvanising after manufacture, with a minimum thickness of 2 mm. Trays located outdoors shall be stainless steel.

Cable trays shall be ladder type. The use of trays of grid type or brake-formed sheet on sections with few cables shall be approved by the client.

As long as it is viable, redundant equipment cables shall be routed through separate raceways.

Cable trays shall have a useful height of at least 100 mm and a width of preferably 150, 300 or 600 mm.

The vertical distance between trays shall never be less than 30 cm.

The tray filling index shall be a maximum 50% of the useful cross-section of the cable tray.

Outdoor cable runs shall be routed in trenches. Cable routing in duct banks shall be subject to the Client's approval.

All cable trays shall be grounded and have perfect electrical continuity between sections.

The conduits supplied shall be steel electro-galvanised on both internal and external surfaces, according to DIN 2440, with NPT at both ends. Sections shall be joined by means of appropriate couplings. Steel fittings shall be used to protect cables at their outlet. Raceways shall comprise discontinuous conduits, unless special installation conditions dictate otherwise. Discontinuous conduit raceways do not require the use of pullboxes or elbows. For single core cables, the three-phases shall be laid in the same conduit. The filling index shall not exceed 53% for one cable in the conduit, 31% for two cables and 40% for more than two cables. All continuous and discontinuous metallic conduits shall be appropriately grounded.

In areas classified as potentially explosive atmospheres, steel conduits for not armour cables shall be used as per ANSI Standard 80.1.

Where cables emerge from the ground or foundation, they shall be protected 250 mm above and below ground by means of a conduit.

The flexible tubes for not armour cables will be formed by flat profile galvanised steel strip and covered with one layer of EPR or similar, resistant to water, oil or grease and flame retardant in accordance with IEC 60332-1.

Cable raceways under roads shall comprise banks of PVC tubes embedded in concrete. For single core cables, the three phases shall be laid in the same tube. The filling index for low voltage cables shall be a maximum of 60% of the useful cross-section of the tube. There shall be a 40% tube reserve in each bank.

Fire barriers shall be installed for cable raceways between all adjacent rooms, cable inlets to switchboards and locations where it is considered necessary for adequate fire protection.

Distribution boxes shall be made from aluminium or plastic materials (polyester fibre highly resistant to corrosion and degradation). Cables shall preferably be inserted through the bottom part.

The cable trays and different types of conduits shall be identified following the same criterion as that used in the BOP. They will be assigned an identification code (KKS) in accordance with the identification criteria indicated in Document No. 428-00-R-D-00202, *Component Identification System*.

Cables shall be connected to equipment by means of suitable cable glands.

Installations in potentially explosive atmospheres shall be in accordance with that indicated in section 3.7.

The requirements and criteria indicated in drawing No. 428-00-D-E-40260, *Typical Details for the Assembly of Electrical Raceways and Cable Routing* shall be taken into consideration for the installation of cables, trays and conduits.

11. ELECTROMAGNETIC COMPATIBILITY

All electric components for mechanical equipment and package plants shall comply with European Directive 89/336/EEC on electromagnetic compatibility with respect to emission and immunity.

The package plant supplier shall issue a Declaration of Conformity based on a Technical Construction File which sets out the Declarations of Conformity supplied by the manufacturers of all components and/or equipment used in the package plant.

Likewise and in accordance with Section 3.10, the Supplier shall issue a declaration of conformity with the EC directives required for the CE marking of the equipment included in the scope of supply.

12. DOCUMENTATION TO BE SUPPLIED

12.1 DOCUMENTS TO BE SUBMITTED WITH THE PROPOSAL

As a minimum, the Supplier shall supply the following documentation with his proposal:

a) One-line diagram of the package plant

b) List of electric equipment included in the supply

c) General electrical data sheets, duly completed, included in Appendix A

d) Technical data sheets of all the electrical equipment

e) Dimensional drawings and duly completed data sheets for each of the electric motors with a rated power greater than 18.5 kW and motor-operated valve actuators, included in Appendices B, C and D

f) List of electrical equipment consumptions

g) Dimensional drawings of electric equipment (with cable entry openings)

12.2 DOCUMENTATION TO BE DELIVERED WITH THE PURCHASE ORDER

The Supplier shall deliver the following documents:

a) One-line diagram of the package plant

b) List of electrical equipment items included in the supply

c) General electrical data sheets, duly completed, included in Appendix A

d) Data sheets of all the electrical equipment

e) Dimensional drawings and duly completed data sheets for each of the electric motors and motor-operated valve actuators, included in Appendices B, C and D

f) List of electrical equipment consumptions

g) Dimensional drawings of electrical equipment (with cable entry openings)

h) Internal and external schematic and wiring diagrams of electrical equipment

i) List of cable types and their characteristics

j) List of cables

k) Reports and certificates of tests carried out on electrical equipment

l) Drawing of lighting fixtures and receptacles points, if applicable

m) Drawing of electrical equipment, cable trays and conduit layout

n) Certificates of Conformity with European Directive 89/336/EEC

o) Declarations and Certificates of Conformity with European Directive 94/9/EC, if applicable

p) EC Declaration of Conformity for CE marking

q) Equipment descriptions, instruction manuals for storage, erection, commissioning, operation and maintenance, and electrical equipment catalogue, all in Portuguese.

The following documentation shall be provided for the motor control centres, miscellaneous panels and cabinets included in the supply:

a) General arrangement drawings with dimensions and all views necessary

b) Installation conditions to ensure compliance with European Directive 89/336/EEC

c) Drawings of bedplates including weights and cable entry openings

d) Component arrangement drawings, including location of terminal blocks

e) Internal wiring electrical diagrams

f) Drawings and information on all components and accessories

g) Lists of components and materials

h) Data sheets

APPENDIX A

GENERAL ELECTRICAL DATA

MECHANICAL EQUIPMENT _____

MAIN SPECIFICATION NO. _____

NAME OF BIDDER: _____

1. Electrical installation one-line diagram, document No. _____
2. List of electrical equipment, document No. _____
3. MCC/panel manufacturer _____
4. Power demand of installation (400 V, 3-phase, 50 Hz):
   - Continuous consumption (A) _____
   - Maximum momentary consumption (A) _____
5. Power demand of installation (400/230 V, 3-phase+N, 50 Hz):
   - Continuous consumption (A) _____
   - Maximum momentary consumption (A) _____
6. Power demand by the facility (230 V, 1-phase+N, 50 Hz – UPS):
   - Continuous consumption (A) _____
   - Maximum momentary consumption (A) _____

MECHANICAL EQUIPMENT _____

MAIN SPECIFICATION NO. _____

NAME OF BIDDER:

7. List of Motors:

Driven Equipment	Rated voltage V	Rated Output kW	r.p.m.	No. of motors	Capacity (2x100,2x50, etc)

APPENDIX B

TECHNICAL DATA SHEETS FOR MEDIUM VOLTAGE MOTORS

(See Appendix A of the Technical Specification for MV Motors. Doc. No. 428-00-I-E-20320)

APPENDIX C

TECHNICAL DATA SHEETS FOR LOW VOLTAGE MOTORS

CHARACTERISTICS	REQUIRED	PROPOSED
0. Driven Equipment		
Identification:		
Main specification no.:		
Manufacturer:		
1. Motor Characteristics		
Manufacturer:		
Quantity:		
Type:	Induction	
Model:		
Stator winding connection (star, star with accessible neutral, delta, etc):	Star	
Type of rotor:	Squirrel cage	
Production and testing standards:	IEC 60034	
Installation (indoor or outdoor):		
Guaranteed power rating (kW):		
Duty type:		
Degree of Protection (IP):	Min. IP55	
Stator winding insulation class:	F	
Stator winding temperature rise above ambient temperature, measured by resistance variation (ºC):	≤ 80 Class B	
Number of phases:	3	
Rated voltage (V):	400	
Rated frequency (Hz):	50	
Allowable variations of voltage and frequency during operation:		
a) Voltage, %	±10	
b) Frequency, %	+2%, -3%	

CHARACTERISTICS	REQUIRED	PROPOSED
Guaranteed minimum startup voltage (%):	80	
Power frequency withstand voltage (V):	2 U_N + 1000	
Speed at full load (rpm):		
Slip at full load (%):		
Full load current at rated voltage and frequency (A):		
Locked-rotor current at rated voltage and frequency (p.u.):	≤ 6	
No-load current at rated voltage and frequency (A):		
Rated torque at rated voltage and frequency (Nm):		
Starting torque at rated voltage and frequency (p.u.):		
Pull-up torque at rated voltage and frequency (p.u.):	> 0,5	
Breakdown torque at rated voltage and frequency (p.u.):	≥ 2,1	
Power factor at rated voltage and frequency:		
a) At full load		
b) At 75% full load		
c) At 50% full load		
Power factor with locked rotor:		
Guaranteed efficiency at rated voltage and frequency:		
a) At full load		
b) At 75% full load		
c) At 50% full load		
Acceleration time (on load):		
a) At rated voltage (s)		
b) At minimum specified startup voltage (s)		
Maximum allowable time with locked rotor:		

CHARACTERISTICS	REQUIRED	PROPOSED
a) At rated voltage, with the motor initially at maximum ambient temperature (s)		
b) At rated voltage, with the motor initially at operating temperature (s)		
c) At minimum startup voltage specified, with the motor initially at maximum ambient temperature (s)		
d) At minimum startup voltage specified, with the motor initially at operating temperature (s)		
Sound pressure level (weighted value of the sound pressure level radiated at 1 m) (dB(A)):	≤80	
Bearing type (ball, sleeve, etc.):		
L10 rated life of bearings (hours):	80000	
Space heaters (P > 55 kW):	REQUIRED	
Space heater nominal supply voltage (phase and neutral):	230 V, 50 Hz	
Space heater total power consumed at nominal supply voltage (W):		
Number of PT100 (P > 75 kW):	2 per phase + 1 double for each bearing	
Independent terminal boxes for accessories and space heaters:	REQUIRED	
Clamp-type terminal for motor casing grounding:	2 (P>75 kW) 1 (18.5 < P ≤ 75 kW)	
Weight of the rotor (kg):		
Total weight of the motor (kg):		
Motor inertia moment (PD2) (kg/m^2):		
Finish colour:		

CHARACTERISTICS	REQUIRED	PROPOSED
2. Tests		
Routine Tests:		
a) No-load test, with measurement of iron losses and of the no-load current, as per IEEE-112	REQUIRED	
b) Locked rotor test , as per IEEE-112. If the test is carried out at a reduced voltage, provide a measurement of the motor starting current at rated voltage and frequency	REQUIRED	
c) Power frequency withstand test for one minute, as per IEC 60034-15	REQUIRED	
d) Measurement of insulation resistance before and after the dielectric test	REQUIRED	
e) Measurement of winding resistances, as per IEEE-112	REQUIRED	
f) Direction of rotation and phase sequence, as per IEC 60034-8	REQUIRED	
g) Measurement of vibrations and rotor balance, as per IEC 60034-14	REQUIRED	
h) Dimensional check and verification of finish	REQUIRED	
i) Inspection of the motor auxiliary device wiring	REQUIRED	
j) Determination of the magnetic centring	REQUIRED	
k) Operating inspection of the RTDs of windings and bearing	REQUIRED	
l) Measurement and verification of the current symmetry on the three (3) phases	REQUIRED	
m) Overspeed test, as per IEC 60034-1	OPTIONAL	
Type Tests (for all motors under 55 kW) [1]		
a) Noise level measurement at a distance of 1 m, as per IEC 60034-9	REQUIRED	

[1] The type tests may be replaced by type test certificates for motors of the same type.

CHARACTERISTICS	REQUIRED	PROPOSED
b) Determination of losses, efficiency and power factor, as per IEC 600 34-2	REQUIRED	
- at 25% of full load		
- at 50% of full load		
- at 75% of full load		
- at 100% of full load		
c) Establishment of the speed-torque, speed-current and speed-power factor curves, as per IEEE-112	REQUIRED	
d) Temperature rise tests as per IEEE-112	REQUIRED	
e) Off-load and short-circuit testing	REQUIRED	
f) Cold measurement of the gap and after the warm-up test at normal load	REQUIRED	
g) Determination of the moment of inertia for motors greater than or equal to 55 kW	REQUIRED	
Type Tests (for all motors under 22 kW) [1]		
a) Verification of the heating and cooling time constant	REQUIRED	
b) Verification of the time constant of components and of the voltage and current in off-load conditions	REQUIRED	
c) Determining the X/R ratio	REQUIRED	
3. Site verifications and tests		
a) Verification of the list of all materials	REQUIRED	
b) Verification of the complete connection of all the accessories and power, control, signalling and protection circuits, in accordance with the drawings	REQUIRED	
c) Verification of the nominal characteristics marked in the identification plate	REQUIRED	
d) Verification of correct operation of all the auxiliary and protection devices (if any)	REQUIRED	

CHARACTERISTICS	REQUIRED	PROPOSED
e) Determination of the insulation resistance of the stator windings and auxiliary equipment (Megger of 500 V for 1 minute)	REQUIRED	
f) Verification of the free flow of fresh air intake and hot air outlet	REQUIRED	
g) Alignment measure of the semi-coupling between the motor and the operated machine	REQUIRED	
h) Vibration measurement	REQUIRED	
i) Startup current measurement and checking the motor's capacity to support the startup frequencies guaranteed	REQUIRED	
j) Measurement of the current and power factor with service load under rated voltage	REQUIRED	
k) Measurement of the stator heating through temperature sensors	REQUIRED	
l) Verification of the operation of the temperature sensors for the specified values (if any)	REQUIRED	
m) Verification of the functionality of the motor with the activated equipment and with the electric and thermal protection system	REQUIRED	
n) Verification of the motor instrumentation	REQUIRED	
o) Verification of the operation of the heating	REQUIRED	

APPENDIX D

TECHNICAL DATA SHEETS FOR MOTOR-OPERATED VALVE ACTUATORS

CHARACTERISTICS	REQUIRED	PROPOSED
0. Driven Valve		
Valve identification:		
Main specification No.:		
Manufacturer:		
1. Actuator Characteristics		
Manufacturer:		
Type:		
Rated duty time (min):	10	
Duty type:	S2	
Degree of Protection:	IP67	
Colour:		
Rated output (kW):		
Supply voltage (V):	400 ± 10%	
Frequency (Hz):	50 +2%, -3%	
Number of phases:	3	
Insulation class:	F	
Minimum operating voltage at actuator terminals (%):	80	
Contactor connection minimum voltage (%):	80	
Contactor disconnection minimum voltage (%):	70	
Minimum allowable number of starts per hour:		
Rated current (A):		
Locked rotor current (A):		
Maximum operating time with locked rotor (s):		
Continuous operation time at one-third of rated load (min):		

CHARACTERISTICS	REQUIRED	PROPOSED
2. Operation, Protection and Signalling Elements		
Handwheel:	REQUIRED	
Integrated control station:	REQUIRED	
Open/close pushbuttons:	REQUIRED	
Local/stop/remote selector:	REQUIRED	
Motor contactor-starter-inverter:	REQUIRED	
Thermal relays:	REQUIRED	
Adjustable torque switches:	REQUIRED	
Motor protection against stuck valve at the moment of unseating:	REQUIRED	
Thermostatic protection against overtemperature:	REQUIRED	
Protection against single-phase loss:	REQUIRED	
Self-locking device upon power failure:	REQUIRED	
Position transmitter (4-20 mA) for regulating valves:	REQUIRED	
Hammer blow:	REQUIRED	
Number of position contacts:	4 configurable	
Contact breaking current capacity (current and voltage):	5 A at 250 VAC or 48 VDC	
Space heater:	REQUIRED	
3. Tests		
Routine tests to be carried out on the motors (actuators) required by IEC-60034:	REQUIRED	

CHARACTERISTICS	REQUIRED	PROPOSED
Routine tests to be performed on the assembly of motor-contactor starter inverter, thermal relays, actuator switches, wiring, etc. in accordance with the relevant IEC standard and with at least the following: - Wiring check - Dielectric strength test and power frequency - Insulation resistance measurement - Operation check	REQUIRED	
Type tests performed on the same and/or similar motor actuators and starter equipment	CERTIFICATE IS REQUIRED	

APPENDIX E

DIAGRAMS OF THE MAIN AND AUXILIARY TERMINAL BOXES FOR MV MOTORS

(See Appendix B of the Technical Specification for MV Motors. Doc. No. 428-00-I-E-20320)

APPENDIX F

QUALIFIED MANUFACTURERS

(Pending)

CLASSIFICATION

Contains information for the design of structures, systems or components: Yes ☒ No ☐

Design verification : Not applicable ☐ Head of OU/Supervisor ☒ Verifier Level 1 ☐ Level 2 ☐

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CONTENTS

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1. GENERAL

The purpose of this document is to establish the basic technical requirements for the piping and valves in the package plants which will be installed in Lares combined cycle power plant. These requirements are additional to those defined in the Plant design basis document and in the applicable package plant specifications.

These requirements cannot be modified without the approval of the Purchaser, who may accept or reject the proposed changes, which should be requested officially, should be duly justified and consequently be approved.

2. METALLIC PIPING

The metallic piping to be used in the installation shall be standardised and shall comply with the applicable legislation in force and with the requirements indicated below. The basic design Code shall be ASME/ANSI B31.1 (Power Piping).

The piping materials shall be suitable for the fluid it contains under the maximum operating conditions.

The maximum admissible temperature for the carbon steel piping and components shall be 400ºC. Galvanised steel and copper piping shall only be used when explicitly indicated in the technical specifications or when approved by the Purchaser.

The piping for instrument air and sampling shall always be made of stainless steel. Carbon steel piping shall only be used when so indicated in the technical specifications.

2.1 PIPING SIZES

The use of the following nominal diameter (ND) sizes of piping and valves shall be avoided: ¼", 1 ¼", 3 ½", 5" and 22".

2.2 DIMENSIONS

The dimensions of the carbon steel and alloy steel piping shall be in accordance with ASME B36.10M. The dimensions of the stainless steel piping shall be in accordance with ASME B36.19M. Those pipes not included in the scope of ASME B36.19M shall be in accordance with ASME B36.10M. The tubing shall be defined by the external diameter (OD).

2.3 THICKNESSES

The piping thicknesses shall be sufficient to withstand the design temperatures and pressures during the plant's life cycle. The minimum thicknesses to be used in the process piping shall be the following:

- Carbon steel piping
  - ND ≤ 2” Schedule 40
  - ND ≥ 2 ½” Schedule STD
- Alloy steel piping
  - ND ≤ 2” Schedule 40
  - ND ≥ 2 ½” Schedule STD
- Stainless steel piping
  - ND ≤ 2” Schedule 40S
  - ND ≥ 2 ½” Schedule STD
- Stainless steel tubing
  - External diameter: ½” Nominal thickness: 0.049”
- For combustible liquids and flammable products, the minimum thicknesses shall be XS.

The vent and drain piping, starting from the isolation valves, could have thicknesses less than those indicated above.

2.4 JOINT TYPES

Welded

- The piping, accessories and other components shall be joined fundamentally by welding and in accordance with the following criteria:
  - ND ≤ 1 ½” Socket welding (SW)
  - ND ≥ 2 Butt welding (BW)
- For the following services:
  - Steam P> 250 psig (17,2 barg)
  - Water P > 100 psig (6.9 barg) and T > 105ºC

The pipes shall be seamless and have a minimum thickness of Sch. 80.

- The piping weldments shall be performed preferably using sleeves for SW or compression fittings. Pipes shall be joined to equipment with compression couplings which allow the dismantling of the equipment they are connected to.

The preparation of the ends of the terminal points of the equipment or package plants planned for joining using butt welding, shall be in accordance with the following figures and tables.

EMPRESARIOS AGRUPADOS	PROJECT: C.T.C.C. LARES	Issue: 7
	BUTT WELDING END DETAILS	Sheet 1 of 2

tn ≤ 3mm

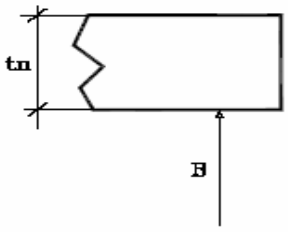


Figure A

3mm < tn ≤10mm

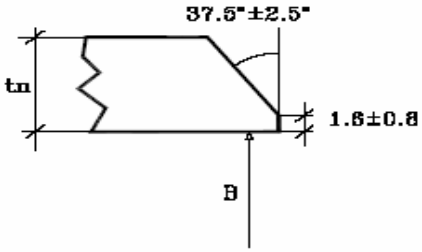


Figure B

10mm < tn ≤ 22mm

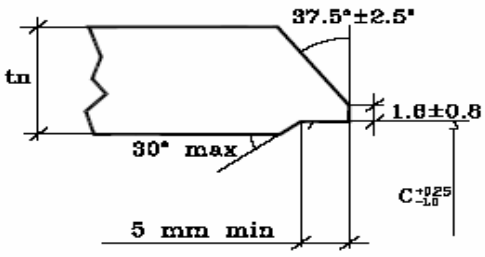


Figure C

tn > 22mm

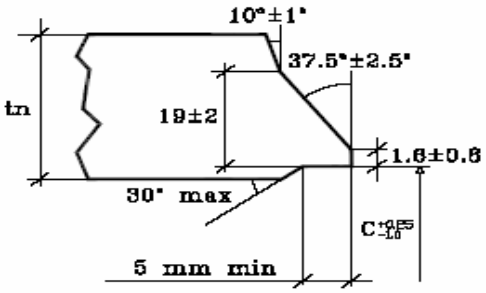


Figure D

tn: Pipe Nominal Wall Thickness

B: Pipe Nominal Inside Diameter

C: Machined Inside Diameter

All dimensions are in mm

EMPRESARIOS AGRUPADOS

PROJECT: C.T.C.C. LARES

Issue 3

WELD END PREPARATION:
"B" AND "C" DIMENSION SCHEDULE

Sheet 2 of 2

DN ------ A	I.D.	PIPE WALL SCHEDULE ASME B36.10M 20	30	STD	40	60	XS	80	100	120	140	160	XXS	ASME B36.19M 10S	40S	80S
½	B			0.622	0.622		0.546	0.546				0.464	0.252	0.674	0.622	0.546
0.840	C			-	-		-	-				-	-	-	-	-
¾	B			0.824	0.824		0.742	0.742				0.612	0.434	0.884	0.824	0.742
1.05	C			-	-		-	-				-	-	-	-	-
1	B			1.049	1.049		0.957	0.957				0.815	0.599	1.097	1.049	0.957
1.315	C			-	-		-	-				-	-	-	-	-
1 ½	B			1.610	1.610		1.500	1.500				1.338	1.100	1.682	1.610	1.500
1.900	C			-	-		-	-				-	-	-	-	-
2	B			2.067	2.067		1.939	1.939				1.687	1.503	2.157	2.067	1.939
2.375	C			-	-		-	-				-	-	-	-	-
2 ½	B			2.469	2.469		2.323	2.323				2.125	-	2.635	2.469	2.323
2.875	C			-	-		-	-				-	1.868	-	-	-
3	B			3.068	3.068		2.900	2.900				-	-	3.260	3.068	2.900
3.500	C			-	-		-	-				2.692	2.409	-	-	-
4	B			4.026	4.026		3.826	3.826		-		-		4.260	4.026	3.826
4.500	C			-	-		-	-		3.692		3.530	3.279	-	-	-
6	B			6.065	6.065		-	-		-		-	-	6.357	6.065	-
6.625	C			-	-		5.828	5.828		5.600		5.326	5.072	-	-	5.828
8	B	8.125	8.071	7.981	7.981	-	-	-	-	-	-	-	-	8.329	7.981	-
8.625	C	-	-	-	-	7.873	7.709	7.709	7.544	7.326	7.163	6.998	7.053	-	-	7.709
10	B	10.250	10.136	10.020	10.020	-	-	-	-	-	-	-	-	10.420	10.020	-
10.750	C	-	-	-	-	9.834	9.834	9.670	9.451	9.232	8.959	8.740	8.959	-	-	9.834
12	B	12.250	12.090	12.000	-	-	-	-	-	-	-	-	-	12.390	12.000	-
12.750	C	-	-	-	11.999	11.725	11.834	11.505	11.232	10.959	10.740	10.413	10.959	-	-	11.834
14	B	13.376	13.250	13.250	-	-	-	-	-	-	-	-		13.624		
14.000	C	-	-	-	13.192	12.920	13.084	12.646	12.318	12.044	11.771	11.498		-		
16	B	15.376	15.250	15.250	-	-	-	-	-	-	-	-		15.624		
16.000	C	-	-	-	15.084	14.811	15.084	14.482	14.155	13.826	13.442	13.170		-		
18	B	17.376	-	17.250	-	-	-	-	-	-	-	-		17.624		
18.000	C	-	17.193	-	16.975	16.646	17.084	16.318	15.936	15.553	15.225	14.842		-		
20	B	19.250	-	19.250	-	-	-	-	-	-	-	-		19.564		
20.000	C	-	19.084	-	18.920	18.538	19.084	18.155	17.717	17.334	16.896	16.513		-		
24	B	23.250	-	23.250	-	-	-	-	-	-	-	-		23.500		
24.000	C	-	22.975	-	22.755	22.263	23.084	21.826	21.280	20.788	20.350	19.857		-		
26	B						-									
26.000	C						25.084									
28	B															
28.000	C															
30	B						-							29.376		
30.000	C						29.320							-		
32	B															
32.000	C															

PIPING SPECIFIED BY WALL THICKNESS

DN	tn	"C"		DN	tn	"C"	DN	tn	"C"	DN	tn	"C"		DN	tn	"C"
			(1) (2)													

NOTES :

DN: Nominal diameter
A: Outside diameter
B: Inside diameter (A - 2tn)
C: Dimension C (Inside diameter machining dimension)
tn: Nominal wall thickness
(1) Left table: Welded pipe
(2): Right table: Seamless pipe

Threads

The use of threaded joints is not permitted in high pressure and high temperature water and steam systems, fuel supply systems and chemical systems using hazardous products; in any case threaded joints shall comply with the following requirements:

- The threads shall be NPT in accordance with ASME B1.20.1
- They cannot be used for temperatures above 495ºC
- The maximum pressures to be used for steam and hot water services (T > 105ºC) are the following:

ND (Inch)	Maximum pressure (barg)
3	25
2	40
1	80
< 1	100

Flanges

Steel flanges shall be in accordance with ASME B16-5 and ASME B16.47 Series A (for ND ≥ 26") and shall be of the type indicated in the following table. The neck flanges shall be drilled with the internal diameter corresponding to the pipe they are connected to.

SIZE	FLANGE TYPE
DN ≤1 ½"	SW / RF
DN ≥ 2"	WN / RF

Cast iron flanges shall be in accordance with ASME B16.1. In the cases where cast iron flanges shall be coupled to steel flanges, the pressure Class equivalents shall be the following:

	Cast iron	Steel
Pressure Class	125	150
	250	300

The flanged coupling joints shall be in accordance with the following table:

Pressure Class	Nominal Diameter	Joint Type
150	All	Non-metallic asbestos-free flat gasket in accordance with ASME B16.21, thickness 1.5 mm
300 ÷ 600	All	Spiral-wound gasket (304 SS) in accordance with ASME B16.20 with external centering ring
900	≤ 20”	
1500	≤ 10”	
2500	≤ 8”	
900	≥ 24”	Spiral wound gasket (304SS) in accordance with ASME B16.20 with external centering ring and internal ring
1500	≥ 12”	
2500	≥ 4”	

The flanged joint bolts shall be of the threaded stud bolt type along the entire length with bevelled ends and two nuts, with cadmium plated surface protection on the carbon steel and alloy steel nuts and bolts.

The stud bolt threads shall be in accordance with ASME B1.1 Class 2A. The nuts shall be hexagonal of the “heavy hex” type in accordance with ASME B18.2.2.

The nut and bolt material in accordance with the piping material shall agree with the following table:

PIPING MATERIAL	STUD BOLT OR SCREW PECIFICATION (ASTM)	NUT SPECIFICATION (ASTM)
Carbon steel	A-193 Grade B7	A-194 Grade 2H
Alloy steel	A-193 Grade B16	A-194 Grade 7
Stainless steel	A-193 Grade B8 Class 2	A-194 Grade 8

Flange joints with different materials, i.e. carbon steel or alloy steel flanges with stainless steel flanges, shall be joined with an assembly of insulation elements (sleeves, metallic washers).

Joint nuts

Joint nuts can be used in cold piping and in piping without pressure of ND ≤ 2”when required for assembly or equipment maintenance. However, this type of joint shall be substituted for flanges whenever assembly is possible.

2.5 BRANCHES

Piping branches shall be at 90º except in those cases where system-specific requirements call for 45º connections, in which case latrolets shall be installed. The criteria for the use of tees, reducer tees and forged accessories (weldolets, sockolets, etc.) shall be obtained from the table below (see Branches Table on page 2-9).

Weldolets shall not be used in those cases where the thickness of the main piping is less than 0.180". In those cases, stub-ins shall be used instead. The connections using stub-ins shall be reinforced if necessary, in accordance with requirements in paragraph 127.4.8 of ASME B31.1.

BRANCH SIZE \ HEADER SIZE	32	30	28	26	24	20	18	16	14	12	10	8	6	4	3	2½	2	1½	1	¾	½
½	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	SR	SR	SR	SR	ST
¾	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	SR	SR	SR	ST	
1	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	SR	SR	ST		
1½	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	SR	ST			
2	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	R	ST				
2½	W	W	W	W	W	W	W	W	W	W	W	W	R	R	R	T					
3	W	W	W	W	W	W	W	W	W	W	W	W	R	R	T						
4	W	W	W	W	W	W	W	W	W	W	R	R	R	T							
6	W	W	W	W	W	W	W	R	R	R	R	R	T								
8	W	W	W	W	W	R	R	R	R	R	R	T									
10	W	W	W	W	R	R	R	R	R	R	T										
12	W	R	R	R	R	R	R	R	R	T											
14	W	R	R	R	R	R	R	R	T												
16	R	R	R	R	R	R	R	T													
18	R	R	R	R	R	R	T														
20	R	R	R	R	R	T															
24	R	R	R	R	T																
26	R	R	R	T																	
28	R	R	T																		
30	R	T																			
32	T																				

KEY

R - BUTT WELDING REDUCING TEE

S - SOCKOLET

SR - SOCKET WELDING REDUCING TEE

ST - SOCKET WELDING TEE

T - BUTT WELDING TEE

W - WELDOLET

Notes:

1) The sockolets can be replaced with half coupling in Pressure Class 150, 300 and 600 piping. The halfcoupling connections shall be made with full penetration welds.

2) The pipe-to-pipe connections can be used in DN ≥ 2 ½" piping for Pressure Class 150 with or without reinforcement (according to ASME B31.1).

3) The butt welding reducing tees can be replaced by weldolets.

2.6 VELOCITIES

The recommended velocities for the design of the package plant piping shall be the following

SERVICE		VELOCITY (m/seg)	
		MIN	MAX
Auxiliary Steam		25	35
Natural Gas			< 20
Gas-Oil (Supply to the Burners)		1.2	3.0
Air Compressed			< 25
Cooling Water	Header	2.5	4
	Branches	1.5	2.5

2.7 METALLIC VALUES

Firstly, the rating established for the valves shall be in accordance with the rating established for the system piping.

The types of valves to be used in the main piping systems and in the operating system at temperature, are the following

SERVICE	SIZE ND ≤ 2”	SIZE ND ≥ 2 ½”
Isolation (On-off)	Globe	Gate valve of flexible wedge
Throttling	Globe	Globe
One direction	Piston Check valve or ball	Swing Check valve or double-flap check valve

In these case the butt-weld preparation shall be according to code, and the material shall be forged or melted.

The types of valves to be used in the auxiliary piping systems are the following:

SERVICE	SIZE ND ≤ 2”	SIZE ND ≥ 2 ½”
Isolation (On-off)	Ball	Butterfly
Throttling	Globe	Butterfly
One direction	Piston Check valve or Ball valve	Swing Check valve or double-flap check valve

In these cases the material shall be suitable for the type of service and with the system fluid and shall always be subject to the Purchaser’s approval.

If flanged or threaded connections are used, they shall be approved by the Purchaser.

Relief or safety valves

The relief and safety valves shall be in accordance with paragraph 107.8 of ASME B31.1.

The safety and relief valves shall be of the spring-loaded and flanged connection type which is specified differently in the corresponding equipment or package plant specification.

The design range of the springs shall be 10% higher or lower than the setpoint pressure.

The relief capacity of the valves shall be such that the overpressure does not exceed 10% of the setpoint pressure.

The tolerance above and below the popping point shall not exceed the following values: 2 psig (0.14 barg) for pressures less than or equal to 70 psig (4.8 barg), 3% for pressures above 70 psig (4.8 barg) and up to 300 psig (20.7 barg) inclusive, 10 psig (0.7 barg) for pressures above 300 psig (20.7 barg) and up to 1000 psig (69 barg) inclusive, and 1% for pressures above 1000 psig (69 barg).

The valves shall be equipped with a lever for manual opening. The elevation device shall be such that the valve disk cannot be locked or maintained in the elevated position when the manual opening lever is released.

It should be possible to modify the relief or safety valve setpoint pressure without damaging the seat surfaces.

The minimum diameter for the safety valves is of 1”

Material valves

All materials of construction and the pressure and temperature rating of valves and accessories shall be suitable for the intended service conditions.

The valves of water-steam circuit should preferentially be manufactured in forged steel and welded, being this condition mandatory for the circuit of overheated steam, feeding and injection water to the boiler and in any case of pressures to 62 bar(the cast valve should be supply as an option)

Materials of construction of valve internals and valve stems shall be in accordance with following tabulation:

VALVE BODY	VALVE TYPE	VALVE INTERNALS AND STEMS
Alloy Steel (Cast or Forged)	Gate, Globe or Check	Stainless steel (of type to suit service conditions) Stems: 13% Cr Seating Surface: Stellited
Carbon Steel (Cast or Forged)	Gate, Globe or Check	Stainless steel (of type to suit service conditions) Stems: 13% Cr
Cast Iron	Gate, Globe of Check	Bonze Stem: Silicon bronze Disc: DN 50 mm & smaller: 316 stainless steel or Al-bronze
	Butterfly	DN 60 mm and larger: Ductile iron with 316 Stainless steel edge. Shaft: Stainless steel Seat: Buna-N or EPDM rubber
Bronze	Gate, Globe or Check	Bronze Stem: Silicon bronze
Ni-A1 Bronze	Ball	Ball and stem: Monel (for sea water) Seats: reinforced Teflon

VALVE BODY	VALVE TYPE	VALVE INTERNALS AND STEMS
Ni-A1 Bronze	Butterfly	Disc: Ni-A1-Bronze (ASTM A148 alloy 958) with Monel K-500 edge welded overlay) Shaft & internal bolts: Monel 400 or K-500 Seat: Inconel 625
	Check	Monel Seat: Buna-N or EPDM rubber
Ni-Resist	Butterfly	Disc: Ni-Al Bronze (ASTM Bronze (ASTM A148 alloy 958) Shaft: Monel 400 or K-500 Internal bolts: Stainless steel Seat: 316L Stainless steel
	Gate, Globe or Check	304 Stainless steel seating Surface: Stellited
Stainless Steel Type 304	Ball	Ball and stem: 304 stainless Steel Seats: Reinforced Teflon
	Butterfly	Disc: 304 Stainless steel per ASTM A743 Gr. CF-8 Shaft, internal bolts and seat: 304 Stainless steel
Stainless Steel Type 316L	Gate, Globe or Check	316L Stainless steel Seating surface: Stellited
	Ball	Ball and stem: 316L stainless steel Seats: Reinforced Teflon
Stainless Steel Type 316L	Butterfly	Disc: 316L stainless steel Per ASTM A743 Gr. CF-3M Shaft, integral bolts and Seat: 316L stainless steel
Unplasticised PVC (UPVC)	Ball	Ball and stem: UPVC-I Seats: Teflon
	Check	Seats: Fluorine rubber (for water service only)
	Diaphragm	Diaphragm: Teflon or EPDM (Neoprene for water service)
Chlorinated PVC (C-PVC)	Ball	Ball and stem: C-PVC Seats: Teflon
	Check	Seats: Fluorine rubber

3. PLASTIC PIPING

The materials that can be used for the plastic piping are those indicated below and shall be in accordance with the corresponding material specifications or standards.

- Polyethylene (PE)
- Polypropylene (PP)
- Polyester reinforced with fibre glass (PRFG)
- Polyvinyl Chloride (U-PVC)

Other materials can be used which have been previously justified by the Supplier and approved by the Purchaser.

The plastic materials corresponding to overhead piping shall be protected against ultra-violet rays from the sun.

3.1 DESIGN

The correspondence between nominal diameters (ND) in inches and the external diameter (Ed) in millimetres for the polyethylene, polypropylene and polyvinyl chloride piping is the following:

ND (inch)	½	¾	1	1 ½	2	2 ½	3	4	6	8
Ed (mm)	20	25	32	50	63	75	90	110	160	225

The correspondence between the nominal diameters (ND) in inches and the internal diameter (Di) in millimetres for the polyester pipes reinforced with fibre glass is the following:

DN (inch)	1	1½	2	2½	3	4	6	8
Di (mm)	25	40	50	65	80	100	150	200

For the piping thickness calculation, as well as the effects of pressure and temperature, the Supplier shall also take into account the stresses due to other loads such as flexible hangers, the load of the filler in the case of underground piping, etc.

Branches, changes in diameter and closures shall be carried out using standard accessories.

In theory, threaded joints are not permitted, however it they are needed, the minimum thickness of the piping shall be Schedule 80.

The valves and metallic components in line shall be supported independently from the piping.

3.2 MANUFACTURING AND ASSEMBLY

The joints of the polyethylene and propylene piping shall be fused using procedures qualified in accordance with ASTM D2657 or equivalent and according to the following techniques:

- Piping ND ≤ 3” Socket fusion (SF)
- Piping ND > 3” Butt fusion (BF)

The polyester piping joints shall be laminated (butt and wrap) using procedures qualified in accordance with ASTM C682 or equivalent.

The U-PVC piping joints shall be bonded using a procedure qualified in accordance with ASTM D2855 or equivalent. The joint adhesives shall be in accordance with ASTM D2564 or equivalent.

Defective materials and joints shall be repaired or replaced. The limits of the unacceptable imperfections are the following:

- Internal protuberances greater than 25% of the piping thickness
- Filling or fusion faults in joint areas

Flanged joints

In theory, the flanged joints that can be used in the plastic piping are the following:

- Connection between plastic piping and metallic piping
- Connection between plastic piping and equipment nozzles
- Connection between the plastic instrumentation tap and instrumentation metallic piping

The flanged end of the plastic piping shall be formed by a plastic flange adapter or stub flange and a metallic backing ring. The stub flanges can be for butt fusion, socket fusion or bonding and with flat faces or notched faces. The backing rings can be for connecting to flanges according to EN 1092, DIN 2501 or ASME B16.5.

The joints shall be of the flat gasket type with a thickness of 2-5 mm (depending on the diameter of the piping), elastomer material compatible with the process fluid (EDPM, etc) with a maximum hardness 70º Shore-A.

The flanges that shall be coupled to equipment flanged nozzles shall have the same faces as those of the equipment and in accordance with the same corresponding standard.

The flanged joint nuts and bolts shall be of the threaded stud bolt type along the entire length with bevelled ends and two nuts. If joints are used with non-metallic flanges, flat washers shall be used under the nuts. The maximum torque value specified shall not be exceeded.

Threaded joints

In very particular cases, threaded joints can be used between plastic and metallic ND ≤ 2” piping when they are need for assembly or equipment maintenance. They shall be connected using plastic-metal adaptor accessories which are fused or glued to the plastic piping and the metallic part is threaded, the two parts of the accessory being joined by a connecting bolt.

3.3 INSPECTION AND TESTING

Visual Examination

The visual examination shall be performed in accordance with Article 9, Section V of ASME BPVC or equivalent code.

The examination required shall be as follows:

- 100% of all the connections, whether fused, laminated, bonded or flanged.

Pressure Test

Once the plastic pipes have been assembled they shall undergo leak tests in accordance with the requirements of paragraph 137 of ASME B31.1.

The test pressure shall be 1.5 times the design pressure and shall last for at least 10 minutes.

3.4 PLASTIC VALVES

For nominal pressures NP ≤ 10 plastic valves shall be used in accordance with the following criteria:

SERVICE	SIZE ND ≤ 2”	SIZE ND ≥ 2 ½”
Isolation (On-off)	Ball	Butterfly
Throttling	Diaphragm	Butterfly
One direction	Ball check valve	Swing Check valve or double-flap check valve

For nominal pressures NP > 10 when there are no plastic valves, the corresponding metallic valves shall be used

4. INSULATION

When piping and equipment insulation is included in the scope, the following criteria shall be taken into consideration.

Personal protection and thermal insulation

Hot surfaces shall be insulated to prevent thermal leaks and/or avoid injuries to personnel. All surfaces which reach an external temperature equal to or higher than 60 ºC under normal conditions shall be insulated to prevent thermal leaks. The thickness of the insulation shall be suitable to reach a surface temperature no higher than 60 ºC at ambient temperature conditions of 40 ºC. A surface temperature of 50 ºC shall be required to avoid injuries to personnel

Anticondensation insulation

All cold components and piping located inside the buildings shall be insulated to avoid condensation forming when the temperature inside the buildings is less than 13ºC in summer or 4ºC in winter.

Insulation for protection against freezing

At least the ND ≤ 4” piping and other components that are assembled outdoors shall be insulated to avoid freezing if extreme ambient conditions drop to temperatures below 0ºC. The insulation thickness will be at least 80 mm

The insulation for protection against freezing in pipes from 6” to 14” must be considered according to the minimum environmental temperature.

All the instrumentation components pipes and the process pipes below 2½” shall also be protected against freezing using heat tracing when the environmental temperature drop below 2 ºC.

Metallic coatings and insulation materials

The insulation materials shall be standard catalogue products from a manufacturer that regularly sells them. Preferably the following material recommendations shall be followed:

Material density shall be ≥ 90 kg/m^3

Piping of 4” or less: Rock wool mould cemented with Roclaine 315, 315-M type synthetic resin or similar.

Piping greater than 4” and equipment: Rock wool blanket with a Roclaine 342-G type galvanised metallic mesh frame, or similar.

The external face of the thermal insulators shall be protected with an aluminium sheet coating with a thickness of 1 mm for equipment and at least 0.8 mm for piping ≥ 10” and 0,6 mm for piping < 10”

5. PIPING SUPPORT AND FLEXIBILITY ANALYSIS

5.1 APPLICABLE CODES AND STANDARDS

Piping Analysis

- ASME B31.1. POWER PIPING. ASME CODE FOR PRESSURE PIPING

Structural Support Calculation

- AISC Manual of Steel Construction Ed.9. Specification for Structural Steel Buildings. June 1, 1989
- ASME B31.1. POWER PIPING. ASME CODE FOR PRESSURE PIPING

Applicable Loads

- UBC 97. Uniform Building Code

5.2 ANALYSIS REQUIREMENTS

A formal piping analysis shall be performed in accordance with ASME B31.1 on all those pipes whose design temperature is greater than or equal to 150ºC.

A formal analysis is one which is performed using a suitable computer program such as CAESAR, CAEPIPE or similar.

This analysis shall validate the design and flexibility of the piping as well as the stress state and shall distribute the loads to equipment connections, the type of support suitable in the lines as well as the stresses in the supports.

It would also be recommendable to perform a formal analysis on those pipes with a design temperature below 150ºC under the following conditions:

- Pipes which have high thermal displacements because of their length.

- Pipes with connections to equipment where stresses would have to be guaranteed at their connections

- Pipes with a diameter less than 2 ½" with temperatures close to the established limit or connected to equipment or larger pipes with high thermal displacements

For the rest of the pipes (with a design temperature below 150ºC) it is not mandatory to perform a piping analysis using formal methods; simplified methods or engineering good practice maybe used.

5.3 SUPPORT CALCULATION REQUIREMENTS

The requirements of the calculation of the supports are the following:

- In those cases where structural supports need to be used, instead of catalogue supports, or auxiliary structures, said supports shall be designed in accordance with typical typologies backed-up by calculations using manual methods or with the use of computer programs so that compliance with the applicable codes is guaranteed

The stresses shall be calculated in accordance with the AISC Manual of Steel Construction and the admissible stresses shall be in accordance with ASME B31.1.

6. VALVE ACTUATION

Manually actuated valves shall operate smoothly without seizures or vibrations and levers or other accessories shall not be needed for opening or closing.

All the manual valve actuators shall be easily accessible.

The valve actuation handwheel shall always rotate in an anti-clockwise direction when opening. These opening and closing directions shall be clearly indicated on all handwheels.

Valves that require a stress over 45 kg applied to the edge of the handwheel for opening or closing under maximum pressure and temperature conditions, shall be equipped with a gear reducer or an “impact wheel” so that the manoeuvre can be performed by just one operator.

The manual valves that require signalling shall be fitted with limit switches.

Valves actuated by electric motor shall comply with the requirements established in the document “Electrical requirements for mechanical equipment and package plants”

OFERTA TECNICA

Ingersoll Rand Industrial Technologies

RENAULT

Jesus Rodriguez Rodriguez

Lugar de Fabricación: Unicov

Compresor de tornillo rotativo exento de aceite modelo SM150 WC

INTRODUCCION

El SIERRA, es un compresor rotativo de tipo tornillo helicoidal de dos etapas para comprimir aire **100% exento de aceite**.

Es un conjunto motocompresor completo accionado por un motor eléctrico sobredimensionado para servicio continuo. La unidad se suministra con todas las tuberías conectadas, cableada y montada sobre un bastidor de acero común, con arrancador estrella-triángulo y panel de control por microprocesador integrales, probada y embalada para su expedición. El conjunto completo se suministra insonorizado en el interor de un cerramiento de paneles fácilmente desmontables para cualquier tarea de inspección o mantenimiento.

El aire ambiente aspirado se conduce, a través de la válvula de admisión al filtro de aire y con posterioridad a la primera etapa compresora. A lo largo de todo el perfil asimétrico de los rotores macho y hembra, el aire se comprime en la primera etapa hasta alcanzar la presión interetápica de diseño. Inmediatamente después el aire entra en el refrigerador intermedio, donde se enfría hasta la temperatura de aspiración de la segunda etapa. La condensación que aparece tras el proceso de refrigeración se retiene dentro del separador de humedad y se purga a través de la electroválvula de drenaje automática de condensación.

El aire comprimido entra después en la segunda etapa para ser comprimido hasta un valor de presión de descarga ligeramente mayor a la nominal del compresor, posteriormente es enfriado en el refrigerador final hasta la temperatura de descarga final de diseño. La condensación que nuevamente aparezca es retenida en el separador de humedad y se descarga a través de las electroválvulas de drenaje automático.

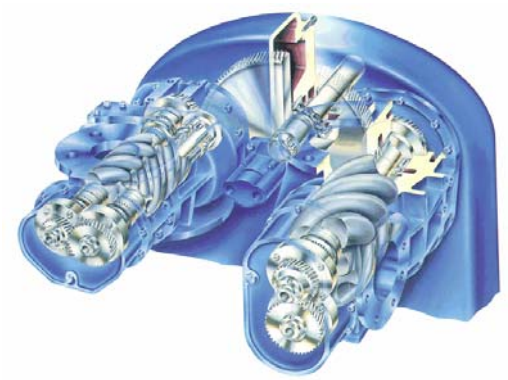
El funcionamiento de conjunto a plena carga es extraordinariamente silencioso, sólo **76 dBA**, está asegurado, según se ha mencionado más arriba, por una cubierta completa de atenuación de ruidos. La cabina de insonorización está construida a base de paneles de cierre rápido para facilitar el acceso y mantenimiento.

El conjunto completo del compresor SIERRA está fabricado, ensamblado, probado y preparado para su expedición de acuerdo a rigurosas normas y

procedimientos de fabricación propios de INGERSOLL-RAND, las prescripciones de la UE y la garantía de calidad certificada por el LQA conforme a **ISO 9001**.

ALCANCE DE SUMINISTRO:

- Filtro de aire de aspiración de alta eficacia preparado para ambiente especialmente polvoriento (HDF = 3μ 99%) alojado en el interior del cerramiento para mayor amortiguamiento acústico global.
- Módulo de compresión de alto rendimiento diseñado para ciclo de trabajo contínuo y pesado. Esta formado por un engranaje principal multiplicador que actúa sobre dos módulos airend (uno para cada etapa compresora) rotativos de tipo tornillo seco , engranajes de alta calidad, precisión clase AGMA 12, sin delicados pistones de compensación empuje y adecuado sobredimensionamiento para una mayor fiabilidad.



- Accionamiento directo motor-compresor por medio de acoplamiento de tipo engranaje seco.
- Sistema completo de lubricación con filtro de aceite de flujo completo, refrigerador, válvula termostática, sistema regulador de presión y bomba de aceite de desplazamiento positivo accionada por el propio eje del engranaje principal. El sistema dispone de una fiable instrumentación para control y protección del sistema.
- Motor eléctrico principal diseñado y sobredimensionado para su aplicación en compresor de aire.
- Refrigerador intermedio aire-aire de tipo haz aleteado con separador de humedad y drenajes automáticos de condensación para cada uno. Sobredimensionados para garantizar el funcionamiento seguro del compresor con temperaturas de entrada de agua de hasta 46 ºC.
- Amortiguadores de pulsación y acústicos en la descarga de cada etapa compresora.
- Refrigerador agua-aceite.
- Motor del ventilador IP54, de 0,75 kW con capacidad de impulsión efectiva de 60 mm de columna de agua.
- Tuberías de descarga del circuito de aire de cada etapa entre airend y refrierador de acero inoxidable AISI 304 para evitar la corrosión y con juntas flexibles igualmente de acero inoxidable.
- Amortiguadores de vibración motocompresor-bastidor para garantizar un funcionamiento estable del conjunto.

- Microprocesador de control ***INTELLISYS*** exclusivo de Ingersoll-Rand presenta el control hoy por hoy mas avanzado para compresores de aire.
- Instrumentación completa con protección integral, avisos de alarma y disparo de protección.
- Control de capacidad todo/nada con rearranque automático del compresor tras las paradas por marcha en vacío en períodos de baja demanda de aire.
- Válvula de control de aspiración con actuador hidraulico y enclavada mecanicamente con la válvula de soplado en vacío. Se trata del dispositivo de control más robusto, simple y fiable de cuantos diseños posibles en compresores de aire exentos de aceite.
- Arrancador Y-Δ integral al panel de control local con protección IP54, tensión de control 110 V/ I / 50 Hz
- Válvula antirretorno de descarga ubicada inmediatamente antes del separador de condensados de segunda etapa para total seguridad.
- Válvulas de seguridad en la descarga de cada etapa compresora.
- Llenado de aceite inicial.
- Conjunto compresor de dos etapas completo, con tuberías ensambladas, cableado y listo para su rápida conexión a red de usuario y puesta en funcionamiento.
- Cubierta de atenuación de ruidos con paneles de cierre rápido para una fácil accesibilidad.
- Test de prestaciones del compresor según ISO1217:1996 para compresores volumétricos.

DOCUMENTACION

- Documentación necesaria para la validación del proyecto y cumplimiento con las especificaciones de EA

CARACTERISTICAS DE DISEÑO

Temperatura ambiente máxima de aire de aspiración de hasta **46º C**. Se garantiza la fiabilidad incluso en entornos hostiles de elevada temperatura ambiente.

Conjunto refrigerado por agua

Los intercambiadores de calor refrigerados por agua, totalmente integrados y montados, están diseñados para una temperatura máxima de agua de refrigeración de 46ºC, resultando un CTD (diferencia de temperaturas frías) de entre 5,3ºC y 8,3ºC. Se incluyen también montados una válvula solenoide para el agua de refrigeración y un pequeño ventilador para la carcasa.

Los refrigeradores del compresor SIERRA están diseñados para que éste pueda trabajar de forma contínua y eficiente a temperaturas ambiente de hasta 46ºC

y todavía garantizar un correcto CTD(8,3ºC). Todos los intercambiadores están diseñados con arquitectura de tubo y carcasa. Para proteger al refrigerador intermedio y al refrigerador posterior de daños por pulsaciones del aire, e aire se canaliza dentro de los tubos del intercambiador y el agua por el exterior de estos, dentro de la carcasa. El refrigerador de aceite utiliza la configuración opuesta con el agua circulando directamente dentro de los tubos y el aceite por el exterior de estos.

Los refrigeradores intermedio y posterior utilizan de forma estándar tubos de cobre, placas de acero al carbono niquelado y mallas de bronce. Para aumentar su fiabilidad, la tapa del la parte "caliente" del intercambiador está fabricada de hierro de fundición con un recubrimiento resistente a la corrosión.

Módulos de compresión

Dos airends diseñados para ciclo de trabajo pesado e ininterrumpido. Rotores macho-hembra de acero forjado sobredimensionados para minimizar velocidades de giro y por lo tanto desgastes.

Los rotores y las superficies de las carcasas están recubiertos con una microcapa sintética de Disulfuro de Molibdeno exclusiva de INGERSOLL-RAND que proporciona protección contra la corrosión durante toda la vida operativa de cada cámara compresora.

Engranajes de Sincronización de máxima calidad para mantener al mínimo las holguras de rotación garantizando al tiempo el máximo rendimiento volumétrico del compresor. Tanto éstos como los engranajes de transmisión de potencia son engranajes calidad AGMA 12.

Dos (2) Rodamientos de tipo bola y cuatro (4) de rodillo por airend seleccionados para compensar toda clase de cargas de empuje y radiales respectivamente, por lo que no son necesarios los delicados pistones de compensación axial de diafragma neumático.

La carcasa del airend de la primera etapa no precisa de refrigeración interna. Está totalmente refrigerada por el aire de ventilación interna, mientras que en el airend de la segunda etapa está internamente recubierta de una camisa refrigerada por el propio aceite del sistema de lubricación de la unidad, evitando de este modo las camisas de refrigeración interna por agua dados los cuidados (limpieza) que precisan los circuitos de agua de refrigeración que cubren superficies de temperatura muy elevada (por encima de los 150ºC).

Los anillos de sellado del aire son de tipo mecánico de acero inoxidable mientras que los de sellado de aceite son de tipo laberinto para ambos airends de primera y segunda etapa.

El eje del engranaje principal presenta un sello de tipo labial. El diseño de todos los sellos ha sido realizado para garantizar un sistema fiable exento de aceites.

Los amortiguadores de pulsación montados en la descarga de cada etapa compresora garantizan un flujo de aire suave. Ello, unido al sistema de aislamiento de vibraciones del tren de accionamiento, permite realizar la instalación sin necesidad de cimentación especial alguna.

Conexiones tóricas SAE O-ring en todas las tuberías de lubricación para garantizar un sistema libre de fugas de aceite.

Control

El microprocesador ***INTELLISYS*** del SIERRA presenta un display de información tal y como se muestra más abajo. Proporciona un texto claro en idioma castellano, sin códigos, de todos los parámetros de funcionamiento con niveles escalonados de alarma y disparo. El sistema controla 12 parámetros de operación con una frecuencia operacional de 20 veces por segundo. El controlador estándar ofrece acceso a 10 parámetros de operación ajustables y 16 funciones con puntos de alarma o disparo.

Se accede a todos los ajustes y a la información del display de modo muy sencillo a través de un panel tipo táctil de membrana sensible, no se necesitan en absoluto herramientas de programación o ajuste externas. En cuanto a comunicaciones, este controlador ofrece un puerto de comunicación serie RS485 como estándar. Dispone de contactos para arranque/parada remoto y alarma común.

Panel de control del *INTELLISYS:*

En el Intellisys se monitorizan los siguientes parámetros operativos:

FUNCIONES DE LECTURA	**ALARMA / DISPARO**
- Presión de descarga del conjunto.	Ajustable por el usuario
- Temperatura de descarga del conjunto.	
- Temperatura de descarga de primera etapa.	D
- Temperatura de aspiración de segunda etapa.	D
- Temperatura de descarga de segunda etapa.	D
- Temperatura de aceite en cojinetes.	D

- Horas totales de funcionamiento.
- Horas totales de funcionamiento en carga.
- Presión de aceite a cojinetes D
- Caída de presión filtro de aceite
- Nombre de programa y revisión
- Vacuómetro presión de aspiración
- Presión de aspiración segunda etapa
- Presión de descarga segunda etapa
- Filtro de aspiración

PARAMETROS AJUSTABLES

- Presión de entrada en carga / vacío.
- Lead/Lag ON-OFF
- Tiempo del display.
- Tiempo de demora de carga.
- Tiempo de transición estrella-triángulo.
- Intervalo de tiempo de purga de condensación.
- Tiempo de evacuación de condensados
- Control de Secuencia ON/OFF
- Arranque / parada remoto
- Contraste de la pantalla

ALARMAS Y DISPAROS

- Filtro de aspiración bloqueado
- Rotación incorrecta
- Fallo de Sensor
- Alta presión del refrigerador intermedio
- Alta presión de segunda etapa
- Presión de aceite a cojinetes.
- Alta temperatura de primera etapa
- Alta temperatura aire de refrigerador intermedio
- Alta temperatura de segunda etapa
- Fallo del arrancador.
- Sobrecarga del motor principal.
- Sobrecarga del motor del ventilador.
- Fallo arranque/parada remoto
- Parada de emergencia.
- Alta temperatura de aceite a cojinetes

ALARMAS

- Cambiar filtro de aspiración
- Cambiar filtro de aceite
- Cambiar aceite
- Cambiar filtro de condensados
- Comprobar mensaje de revisión

BANDA DE PRESION DUAL

- Para secuenciar dos compresores

HISTORICO DE ALARMAS

Ultimas 15 alarmas del compresor

PROTECCIONES

Además de los elementos de protección del controlador, el compresor dispone de los siguientes elementos mecánicos de seguridad:

- Válvula de desahogo interetápica
- Válvula de desahogo de descarga
- Válvula de desahogo presión de aceite

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Hoja de datos:

Capacidad FAD (a presión indicada) (1):

8.5	barg	870	CFM	24.6	m3/min
8	barg	870	CFM	24.6	m3/min
7	barg	870	CFM	24.6	m3/min
6	barg	871	CFM	24.7	m3/min

Potencia en el eje (a presión indicada):

8.5	barg	211	BHP	157	kW
8	barg	205	BHP	153	kW
7	barg	194	BHP	144	kW
6	barg	183	BHP	137	kW

Potencia específica (a presión indicada):

8.5	barg	24.2	BHP	6.4	kW/m3/min
8	barg	23.6	BHP	6.2	kW/m3/min
7	barg	22.3	BHP	5.9	kW/m3/min
6	barg	21.1	BHP	5.5	kW/m3/min

Potencia del compressor en vacío

Potencia absorbida en vacío	33.5	BHP	25	kW
Presión a plena carga	123	psig	8.5	barg
Presión máxima	126	psig	8.7	barg
Presión mínima de operación	72	psig	5.0	barg

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Módulo de compresión:

Número de etapas de compresión	2	
1ª etapa		
Diámetro del rotor	145	mm
Velocidad del rotor macho	11804	RPM
Velocidad longitudinal	90	m/s
2ª etapa		
Diámetro del rotor	87º	mm
Velocidad del rotor macho	18296	RPM
Velocidad longitudinal	83	m/s

Información del lubricante:

Presión de aceite				
En condiciones normales	45	psig	3.1	barg
Temperatura del aceite				
En condiciones normales	135	ºF	57	ºC
Tipo de bomba de aceite	desplazamiento positivo, tipo engranaje			
Capacidad del tanque de aceite	11	US galones	42	Litros
Capacidad total lubricante	13	US galones	49	Litros

Nivel de ruido:

Nivel de ruido	76	dB(A)

Datos de refrigeración (46ºC temperatura máxima ambiente):

Calor absorbido a 20ºC **(2)**				
Refrigerador intermedio	301	1000 BTU/hr	317	1000 kJ/hr
Refrigerador final	281	1000 BTU/hr	296	1000 kJ/hr
Refrigerador aceite	26	1000 BTU/hr	27	1000 kJ/hr
Total	607	1000 BTU/hr	641	1000 kJ/hr
Temperatura de entrada al				
Refrigerador final	363	ºF	184	ºC
CTD **(3)**	15	ºF	8.4	ºC

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Potencia absorbida por el Ventilador de refrigeración		1 HP		0.8 kW
Flujo de aire de refrigeración	3531	CFM	100	m3/min
Presión estática añadida máxima	0.25	Pulgadas H2O	62	Pa
Calor cedido al ambiente	45	1000 BTU/hr	48	1000 kJ/hr
Aumento de temperatura Del aire de refrigeración	12	ºF	7	ºC
Flujo de agua de refrigeración Necesario **a 27º de entrada**	48	gpm	182	lpm
Aumento de temperatura del agua de refrigeración **a 27º de entrada**	25	ºF	14.1	ºC
Caída de presión **a 5 bares entrada**	10	psid	0.7	bard
Presión del agua **min/max**	3.0/10		barg	

Datos eléctricos:

Motor principal (5)(7)				
Potencia instalada (=nom kW x 1.25 SF)	251	HP	188	kW
Número de polos	2			
Velocidad del motor	2955	RPM		
Eficiencia	95.5	%		
Factor de potencia	0.9			
Corriente a plena carga	380	V	285	Amps
Corriente a plena carga	400	V	276	Amps
Corriente de rotor bloqueado	380	V	2000	Amps
Motor del ventilador				
Potencia en el eje	1.0	HP	0.75	kW
Número de polos	6			
Velocidad del motor	950	RPM		
Eficiencia a plena carga	73	%		
Factor de potencia		0.75		
Corriente a plena carga	380	V	2.1	Amps
Corriente a plena carga	400	V	2.1	Amps
Unidad total				
Potencia total instalada	252	BHP	188	kW
Amperios a plena carga	380	V	287	Amps
	400	V	278	Amps

Información general de construcción (6):

Longitud de la unidad completa	106	pulgadas	2690	mm	
Ancho de la unidad completa	62.5	pulgadas	1587	mm	
Alto de la unidad completa		72.5 pulgadas	1840	mm	
Peso de la unidad	3605	kg			
Peso sólo módulo de compresión	530	kg			
Conexión de descarga de aire	6.0	pulgadas ANSI B16.5			
Conexión de agua (entrada/salida)	2.0	pulgadas ANSI B16.5			
Conexión descarga de condensados Refrigerador intermedio	0.5	pulgadas NPT			
Conexión descarga de condensados Refrigerador final		0.5 pulgadas NPT			
Agujero de entrada para los Cables de alimentación eléctrica	3.03	pulgadas			
	77	mm			

NOTAS

(1) FAD(Free Air Delivery) es el caudal capaz de suministrar elcompresor medido en el punto de descarga de acuerdo con la norma ISO1217 anexo C

(2) Calor cedido incluyendo calor latente

(3) CTD(Cold Temperature Difference) basado en 100ºF/38º de condiciones de entrada del aire con 40% de humedad relativa

(4) El nivel de ruido medido en "condiciones en campo libre" según CAGI/Pneurop, ±3 dB(A)

(5) Datos eléctricos para motores Leroy Sommer

(6) Para más datos de dimensiones consultar el plano de dimensiones generales

(7) Estos datos se mantienen para una altura menor de 1000m sobre el nivel del mar

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C.A.G.I. PNEUROP S5.1

COMPRESSOR SOUND LEVEL TEST.

MACHINE TYPE	SM150W	**SERIAL NUMBER**	2380689
TEST ENGINEER	LH	**DATE**	25/10/2009
TEST SITE	Unicov	**LOCATION**	Czech Republic
RATED DELIVERY	690 ACFM	**RATED PRESSURE**	125 psig
AIREND SPEED RATED		**A/E SPEED MEASURED**	
COMMENTS/ SPECIAL FEATURES			
AMBIENT PRESSURE		**AMBIENT TEMP**	
WIND SPEED		**WIND DIRECTION**	
RELATIVE HUMIDITY		**BACKGROUND NOISE**	46.1 dBA
WEATHER CONDITIONS	clear, cool, damp		
TEST MEASURING RADIUS			
SOUND LEVEL METER TYPE	B&K 2230	**SERIAL NUMBER**	
MICROPHONE TYPE		**SERIAL NUMBER**	0212
PISTONPHONE TYPE		**SERIAL NUMBER**	
OCTAVE BAND FILTER		**SERIAL NUMBER**	0213
COMMENTS			
MICROPHONE HEIGHT	1.5 m	**DISTANCE FROM SOUND SOURCE**	1 m

	Side 1	Side 2	Side 3	Side 4
dBA	76.8	80.5	73.4	75.2
Hz				
31.5	75.3	76.7	73.7	79.3
63	71.9	73.8	69.5	69.5
125	68.8	76.1	70.1	70.0
250	69.7	79.0	71.7	72.3
500	70.1	76.2	71.1	73.7
1000	68.7	70.3	65.8	65.3
2000	69.5	71.8	66.5	65.1
4000	68.8	71.2	64.7	68.2
8000	68.0	74.6	62.5	63.4

Measured dBA: **77.5** (Average + 1)
Corrected dBA: **77.2** (Average + 1)

Side 1 is the Intellisys side, Side 2 is the left / louvered end,
Side 3 is the rear (directly across from Side 1), Side 4 is the right side

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SECADOR ADSORCION D3300IL

Descripción general

INTRODUCCIÓN

Los secadores modelo D3300IL son secadores de adsorción sin aporte de calor diseñados para un mayor rendimiento y una mayor fiabilidad en un sistema de aire comprimido.

El propósito de este documento es describir las principales operaciones y principales componentes de estos secadores. Los secadores de aire D_IL son ideales para proporcionar una gran calidad al proceso y a los instrumentos de la planta de potencia o laboratorio. Combinan un simple diseño con una gran variedad de modelos. Los secadores de adsorción sin aporte de calor Ingersoll Rand están llenos de un material adsorbente que permite obtener un punto de rocío de -40ºC.

Otra de las opciones más importantes ofrecidas con estos secadores es el sistema de gestión de energía que permite un considerable ahorro, al recudir los costes asociados al no producirse un aporte de calor a los secadores. Por último, los secadores D_IL vienen equipados de serie con unos potentes filtros de entrada y salida.

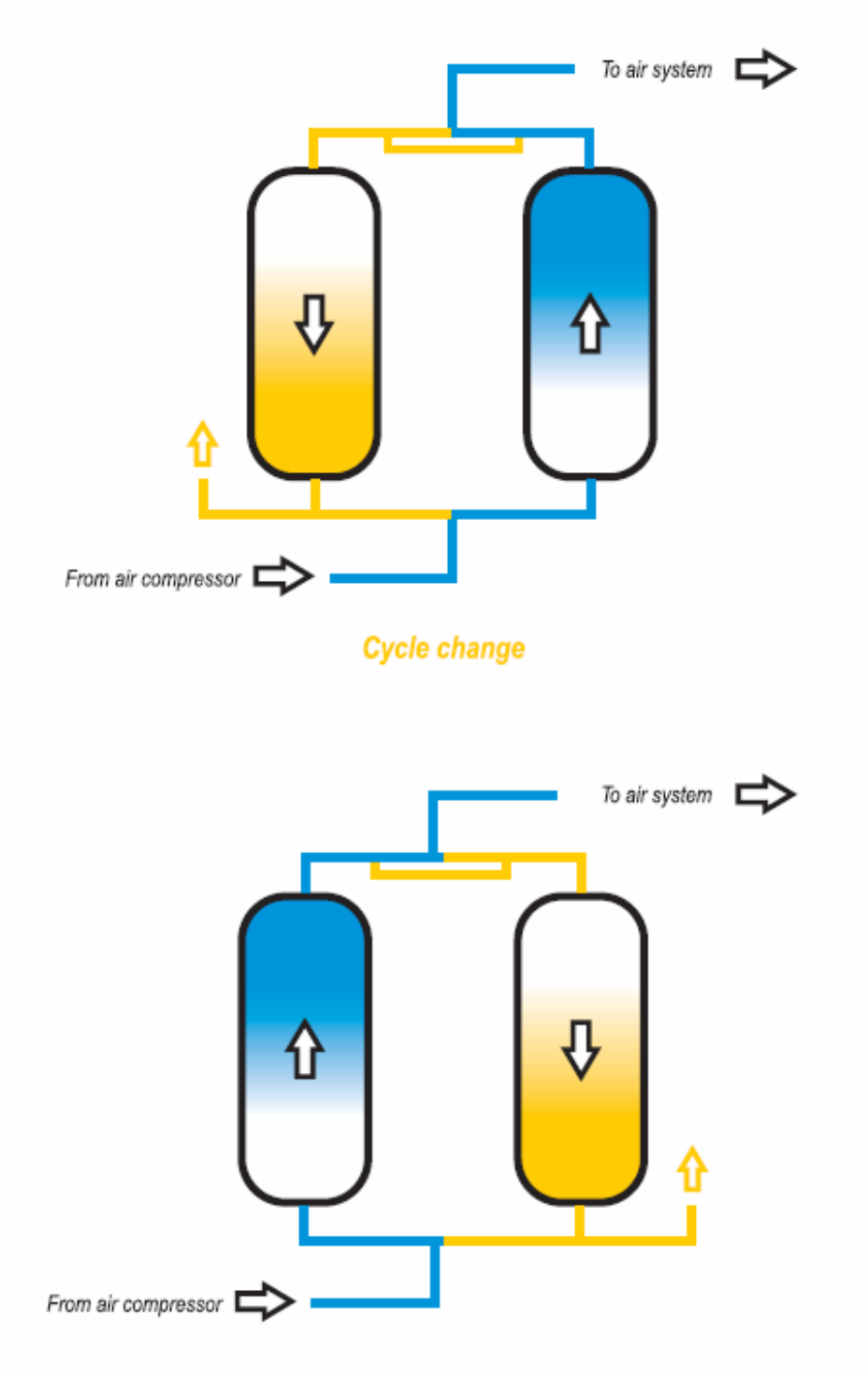
OPERACIONES PRINCIPALES

Los secadores de adsorción sin aporte de calor Ingersoll Rand están diseñados para absorber la humedad del aire comprimido. Los secadores están construidos con dos torres, cada una de las cuales contiene gotas de desecante, que alternan entre estar operativas (secado) o regenerándose, de modo que se obtiene un flujo continuo seco de aire a la salida de los secadores.

Durante la operación normal, el aire húmedo pasa a través de la línea de una de las torres y el vapor de agua del aire es absorbido por las partículas de desecante. Mientras el aire está siendo absorbido en la torre que esta operativa, la humedad que ha absorbido el desecante de la otra torre es expulsado mediante un proceso llamado regeneración. Después de una despresurización inicial rápida, una parte del aire seco de la torre que esta operativa pasa a la otra torre desplazando al exterior a la humedad incrustada en desecante.

El continuo proceso de alternancia de adsorción y desorción se controla mediante un temporizador que cambia de torre en una secuencia de tiempo específico

programado. Los puntos de rocío tan bajos se consiguen mediante el continuo cambio de operación de las torres.



CAUDAL DE AIRE

En las tablas siguientes se puede encontrar el flujo asociado a cada modelo de secador:

	-40ºC Punto de rocío ISO 8573-1: 2001		-70ºC Punto de rocío ISO 8573-1: 2001	
Modelo	m^3/min	m^3/hr	m^3/min	m^3/hr
D3300IL	55.0	3300.0	44.0	2640.0

Datos referidos a las siguientes condiciones:

- Temperatura ambiente = 25 ºC
- Temperatura del aire a la entrada = 35 ºC
- Presión = 7 bar g

Capacidad operativa
Máxima presión de operación = 10 bar (g)
Mínima presión de operación = 5 bar (g)
Máxima temperatura del aire a la entrada = +50°C
Mínima temperatura del aire a la entrada = +10°C
Máxima temperatura ambiente = +50°C
Mínima temperatura ambiente = +10°C
Protección eléctrica = IP54

Componentes y construcción

Cada secador está diseñado con los siguientes componentes:

Indicador de humedad
Filtro Aire Maniobra
Válvula Cierre Aire Maniobra
Tubería de desecante y orificio de llenado.
Torre de desecante
Desecante
Panel de control.
Medidor de presión de la torre
Válvula Ajuste y Manómetro Aire Regeneración
Filtrado
Silenciador
Válvula de escape
Válvulas de cambio de torre
Bastidor
Cuadro eléctrico
Suministro eléctrico
Altura máxima de 3m / Entre la parte más alta y el suelo

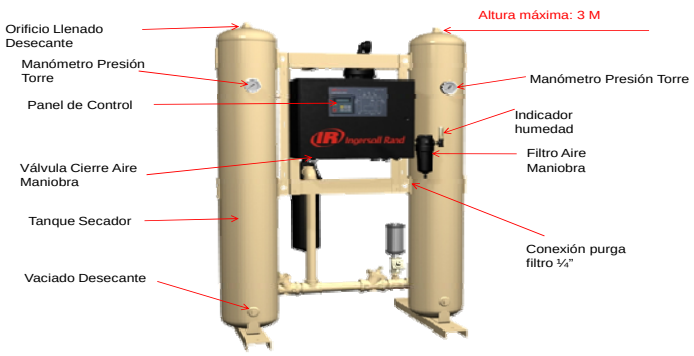
Ingersoll Rand
Industrial Technologies

RENAULT

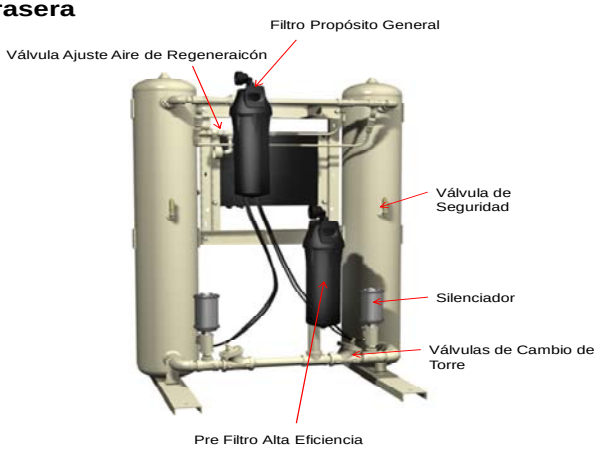
Jesus Rodriguez Rodriguez

Lugar de Fabricación: Unicov

Vista Frontal



Vista Trasera



INDICADOR DE HUMEDAD

Los secadores sin aporte de calor D3300IL están equipados con un medidor de humedad que indica la presencia de humedad en el desecante. Cuando el indicador pasa de azul a blanco significa que el secador tiene humedad en su interior.

FILTRO AIRE DE MANIOBRA

Los secadores sin aporte de calor D160IL -D3300IL están equipados con un filtro para el aire de maniobra. Este filtro es un filtro de polvo (Calidad según ISO 8573.1:2001 / Clase 3 para partículas sólidas) reteniendo partículas menores que 1 micra. El filtro está conectado al panel de control y al flujo de aire del secador para evitar que las partículas de polvo entren en el panel de control y en la válvula de flujo que posteriormente puedan afectar al correcto funcionamiento del secador.

VÁLVULA DE CIERRE AIRE DE MANIOBRA

Los secadores D3300IL cuentan así mismo con una válvula para cerrar el paso del aire a través del filtro del aire de maniobra para permitir el cambio de ese elemento sin tener que parar la unidad entera.

TUBERÍAS DE DESECANTE Y AGUJEROS DE LLENADO.

Las dos torres desecantes están equipadas con una tubería de desecante y un agujero de llenado a través del cual el desecante es aportado o vaciado para labores de mantenimiento. Estos agujeros son de fácil acceso; no hay tuberías ni otros elementos que estorben cuando llenamos o quitamos el desecante.

Agujero del tanque

Agujero de llenado

Nota: usando un aspirador industrial facilitamos el llenado y vaciado de los tanques.

TORRES DE DESECANTE

El corazón de todos los secadores de adsorción se encuentra en las torres del desecante. Para funcionar de forma continua, las dos torres están situadas en paralelo. Todos los modelos D_IL están sellados con el sello de CE. Los tanques de acero inoxidable están provistos en la entrada y en la salida de una boquilla para evitar el arrastre de desecante. Estos recipientes tienen también el certificado PED. Las dimensiones (altura y diámetro) del tanque están calculados para tener una velocidad del flujo por debajo de 20m/min y evitar que la alúmina se desplace a través del tanque.

CE

PED

Documento PED:

El equipo está diseñado de acuerdo a las directivas de la EU:

- Directiva-PED directiva para equipos de presión 97/23/EC
- Directiva SPV- para tanques de presión simples 87/404/EEC
- Directiva LVD-directiva de bajo voltajes 2006/95/EC, directiva para equipos eléctricos.
- Interoperabilidad electromagnética 2004/108/EC, directiva para compatibilidad electromagnética.

Cada secador de la familia D_IL está sometido a una prueba hidráulica, bajo una presión de no menos de 1.43*la máxima presión de trabajo (1.43 * PS). Los secadores D_IB están testados a una presión de: 1.25 * fa / ft

El fabricante ha testado y probado los requerimientos de la soldadura y cumple los requisitos de calidad conforme a SIST

EN 729-2.

La tecnología de soldadura esta aprobada en conforme a SIST

EN ISO 15614-1: 2004 (SIST EN 288-3). Los equipos de

soldadura de acuerdo a SIST EN 287-1, y el personal de

soldadura, conformes a SIST EN 1418.
El control de los trabajos de soldadura se llevará a cabo conforme a SIST EN 719.
El equipo ha presentado toda la documentación necesaria, incluyendo instrucciones de uso, instrucciones del fabricante para el mantenimiento y el certificado de conformidad de todos los elementos estructurales.

DESECANTE

En los estándar (-40°C punto de rocío), los secadores D_IL usan alúmina activa no corrosiva (4-8 mm) para absorber la humedad del aire comprimido. La adsorción se basa en la atracción del desecante al vapor de agua.
Aspectos como la capacidad de adsorción, resistencia, tiempo de contacto, máxima temperatura de entrada, presión de punto de rocío estándar requerido; etc hacen que este desecante sea la mejor elección para este tipo de secadores de adsorción.
Para la opción de -70°C de punto de rocío, los secadores D_IL usan una mezcla de alúmina activa y tamiz molecular. El tamiz molecular ocupa el 25% (en peso) del desecante en lugar del 100% de alúmina activa en los de -40ºC de punto de rocío.
Estos compuestos de tamiz molecular y alúmina activa absorben más cantidad de agua a bajos puntos de rocío hasta bajas humedades relativas.
Por favor, refiérase a la siguiente tabla para las diferentes cantidades de desecante para cada modelo.

Cantidad de alúmina

Modelo	DESECANTE 1/4" mm (kg)	TAMIZ MOLECULAR (kg)
Desecante para -40°C D3300IL	680	227

PANEL DE CONTROL

Los secadores sin aporte de calor de Ingersoll Rand D3300IL están equipados con un controlador en el microprocesador de última generación para mantener unos niveles óptimos en el rendimiento del secador. El controlador del microprocesador controla todas las válvulas neumáticas de operación y las funciones del secador así como las comunicaciones con las alarmas del secador.

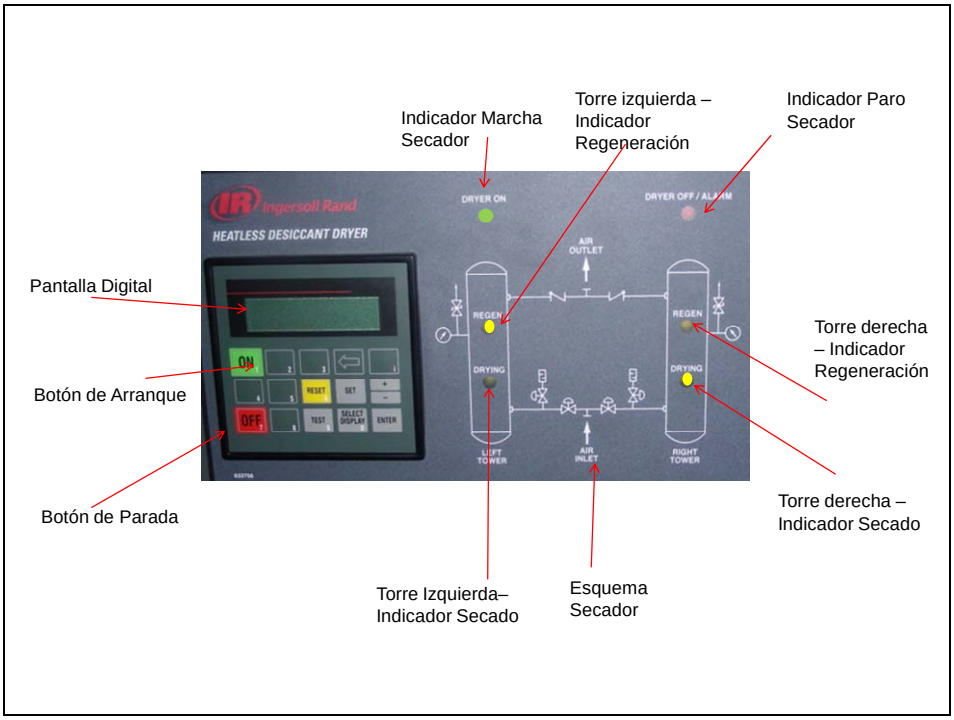
El controlador muestra las últimas 20 condiciones de alarma, mostrando la alarma y la fecha y hora en las que se han producido. Esta función puede facilitar enormemente la solución de problemas del secador.

El controlador dispone de tres niveles de acceso El nivel por defecto, MODO CLIENTE, permite visualizar varios parámetros del secador. Un protegido MODO TÉCNICO permite el acceso y la manipulación de otros parámetros adicionales. El MODO FÁBRICA, protegido con contraseña, se incluye para su uso con el servicio de Ingersoll Rand para solucionar problemas del secador.

Como se describió anteriormente, el panel de control vigila constantemente las funciones del secador y proporciona alertas de mantenimiento que reducen al mínimo el tiempo de inactividad del secador.

El panel de control de los secadores D_IL Ingersoll Rand es también compatible con MODBUS.

El panel de control está fabricado con una pantalla LCD que muestra las diferentes alarmas. Con un diseño esquemático fácil de entender, el panel de control indica cuando el secador está encendido cual es la torre que está en modo secado y cuál es la torre en modo regeneración, si ninguna alarma ha sido reconocida Como se muestra en la imagen inferior, el panel de control de los nuevos secadores D_IL está diseñado para una fácil visión y entendimiento.



Otros parámetros de control incluidos en la pantalla:

- Temporizador de Estado: Pantalla de información que muestra el estado actual en el programa y el tiempo restante para el siguiente estado.
- Tiempo de regeneración y operación: Proporciona acceso a las horas de operación y de regeneración.
- Estado actual del equipo y tiempo restante para el siguiente cambio
- Punto de rocío presión a la salida.

Otras alarmas y sus funciones:

- Comunicación con Compresor: esta función ajusta el funcionamiento del secador para el uso de la regeneración sólo cuando el compresor está en carga o funcionando. Para las instalaciones de almacenamiento al aire libre con almacenaje de aire aguas abajo significativo, esta función cierra las válvulas de purga si el compresor no está produciendo caudal después de completar el ciclo de regeneración de la torre de actual. Tenga en cuenta que esta función se desactiva si el usuario activa el sistema EMS. Ajustando el ciclo de regeneración con el compresor, reducimos los ciclos de carga y descarga en el compresor y ahorramos energía asociada con la innecesaria generación de aire para regeneración.

Modos de reinicio y Visualizaciones:

- Modo reinicio: El controlador del microprocesador incluye una secuencia de apagado que se activa cuando se pulsa el botón off del secador. Esta característica posiciona las válvulas en su posición de fallo seguro, reinicia el programa y es el método más aconsejable de apagar el secador. Cuando el secador se activa de nuevo, está listo para funcionar en el punto inicial de su programa. Si la potencia eléctrica falla inesperadamente, el secador puede rearrancar en uno de sus dos modos de arranque.
- Modo Manual (ZERO): Los secadores de Ingersoll Rand se envían desde fábrica en Modo Manual. Cuando se restablece la alimentación eléctrica tras un fallo de tensión, aparecerá en el display el mensaje “PRESS ON”. Los cambios de válvulas y las operaciones temporizadas empezarán tras presionar el botón ON del panel de control. En esta configuración, para rearrancar el secador el usuario debe presionar manualmente el botón ON en el panel de control.
- Modo Rearranque Automático (LAST): En este modo el secador arrancará automáticamente una vez que el suministro eléctrico vuelva a la unidad. El Microprocesador retomará el ciclo en el punto que estuviera.
- Horas de Operación: En MODO CLIENTE, el controlador dará acceso al total de horas de operación del secador.

MANÓMETRO DE LA TORRE

Ambas torres están equipadas con un manómetro para indicar la presión dentro de los depósitos mientras están funcionando. Estos indicadores pueden ayudar a solucionar estos ejemplos de problemas:

- Caída de presión excesiva en el secador
- Fallo de cambio de torre
- Fallo en el secador al presurizar.
- El secador despresuriza demasiado rápido.
- El secador falla al regenerar.
- Presión en la torre de regeneración muy baja (por debajo de 0.35bar)
- Presión de la torre excesivamente alta en el indicador de purgado.

VÁLVULA DE AJUSTE DE PURGA E INDICADOR DEL FLUJO DE PURGA.

Los secadores sin aporte de calor D160IL a D3300IL están equipados con una válvula de ajuste de regeneración y un indicador del flujo de regeneración. El ajuste apropiado de la regeneración es necesario para lograr un rendimiento adecuado del secador. Ajustar el caudal de regeneración demasiado alto desperdiciará aire comprimido mientras que si la ajustamos demasiado baja el secador no alcanzara el comportamiento apropiado del punto de rocío.

La válvula es de fácil acceso y está justo al lado del indicador de flujo de purga para facilitar el ajuste.

FILTRADO

Para la instalación de secadores de adsorción, es necesario contar con un prefiltro y un postfiltro en el sistema. **Todos los secadores D_IL están provistos con un prefiltro (alta eficiencia) y un postfiltro (de utilidad variada) de forma estándar.**

Añadiendo los prefiltros, situados antes del secador, se protege la capa del desecante de la contaminación del aceite, el agua arrastrado, el oxido de las tuberías, etc., por lo tanto alargamos la vida del desecante del secador. La instalación del prefiltro debe hacerse tan cerca como sea posible del secador.

Es recomendable que un separador mecánico sea instalado inmediatamente antes que del prefiltro para separar la mayor parte de líquidos y agua arrastrados. Los postfiltros de partículas se sitúan después del secador y ayuda a eliminar el posible polvo del descante y arrastrarlo dentro del sistema de aire.

Los secadores D_IL tienen conexiones de entrada y salida situadas en diferentes ejes para facilitar la conexión, la instalación de tuberías y simplificar el mantenimiento.

Prefiltro

- Filtro de alta eficiencia para uso industrial.
  - Calidad del aire ISO 8573.1:2001 / Clase 2 partículas solidas / Clase 2 aceites
  - Eliminación de partículas de hasta 0.01 micras
  - Máximo contenido restante de aceites de aerosoles 0.01 mg/m3 contenido a 21ºC

Postfiltro

- Filtro general para uso industrial
  - Calidad del aire ISO 8573.1:2001 / Clase 3 de partículas solidas / Clase 3 de aceites
  - Eliminación de partículas de hasta 1 micra
  - Máximo contenido restante de aceites aerosoles 0.6 mg/m3 a 21ºC

SILENCIADOR

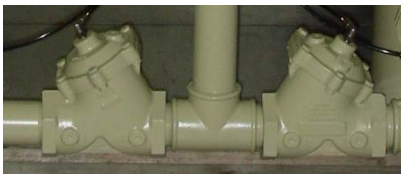
Por cada salida del aire de la purga, un silenciador del aire de purga se encuentra en fondo del secador. Esto asegura un bajo nivel de ruido. A través del diseño de estos secadores la reducción de ruido es un elemento clave que aumenta la comodidad de los empleados en la sala de compresión.

VÁLVULA DE ESCAPE

Los secadores D_IL están equipados con dos válvulas de seguridad para prevenir una alta presión en los depósitos. Las válvulas están diseñadas para operar con una presión por debajo del 10% de la máxima presión nominal (11 bar). El beneficio de estas válvulas es evitar una presión elevada en los depósitos que pueda dañar el secador causando una explosión y dañando enormemente a los usuarios.

VÁLVULAS DE CONMUTACIÓN

Para una operación continua, la corriente de aire comprimido está ciclada entre dos torres de desecante, una absorbiendo mientras la otra está siendo regenerada. Los modelos de secador D_IL están dotados de altos rendimiento integrados a la entrada y de una válvula de cierre que permite un flujo directo a través del secador.



Estas válvulas son fiables, fáciles de mantener y cambiar debido a su sencilla ubicación detrás del secador. Su calidad es impecable con más de 1000 unidades instaladas en todo el mundo.

BASTIDOR

Todos los secadores D_IL están montados sobre bastidores auto portantes fabricados en acero.

CUADRO ELÉCTRICO

El recubrimiento IP54 es el estándar en estas unidades.

SUMINISTRO ELÉCTRICO

Todos los secadores están provistos con el siguiente suministro 230V/1ph/50Hz.

ALTURA MÁXIMA DE 3M / DISTANCIA ENTRE LA CÚSPIDE Y LA BASE

Todos los secadores D_IL tienen una altura de menos de 3 metros, que facilitan su transporte e instalación. Con su compacto diseño, los secadores D_IL se ajustan de pie a los camiones y contenedores estándar, lo que reduce costes de transporte, manipulación e instalación. Para lograr esto la mayoría de los componentes del secador están en la parte trasera, lo que facilita el mantenimiento y el servicio.

SILENCIADOR 80 DB

Para reducir el nivel de ruido de los secadores D_IL se pueden instalar silenciadores en los secadores.

ULTRACARE

El programa de extensión de garantía UltraCare está disponible para los secadores D_IL, incluyendo las siguientes partes:

- Muestra de Desecante
- Elemento para Filtro de Aire
- Pre Filtro
- Post Filtro
- Silenciador regeneración
- Silenciador Aire de Control
- Kit de Servicio Válvula Diafragma
- Desecante (KG)

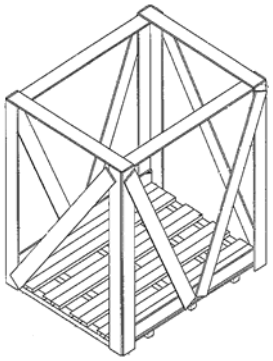
Pruebas

El secador se somete a una prueba de operación y funcionamiento, suministrándose las certificaciones de forma estándar. Los secadores y filtros se fabrican de acuerdo a las normas y estándares marcados por la ISO 9001.

Embalaje

El embalaje es una armadura de madera con fijaciones para mantener el equipo en su sitio.

Véase la imagen como referencia del embalaje ofertado con los secadores D_IL.



Jesús Rodríguez Rodriguez

Ingersoll Rand
Industrial Technologies

Lugar de Fabricación: Unicov

Depósito de aire

MODELO:

Tanque de aire modelo VAC-6000/10.

Este tanque de aire será utilizado en la instalación de aire comprimido para atenuar las vibraciones causadas por la demanda variable de aire comprimido, amortiguación de vibraciones en el sistema por el funcionamiento carga-vacío del compresor y para conferir una autonomía al sistema de aire comprimido de unos minutos hasta cerrar los elementos que puedan dañarse por falta de presión.

CARÁCTERÍSTICAS:

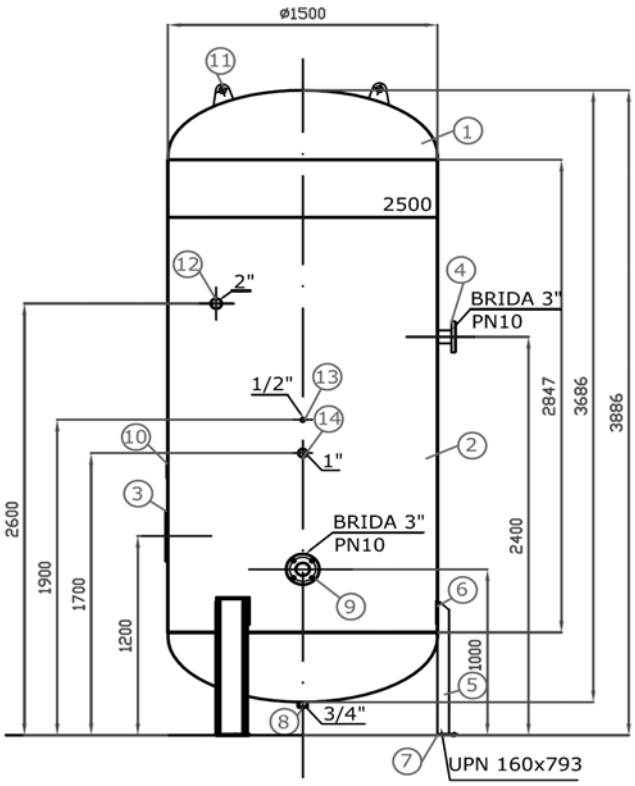
Material:	S355J2G3
Código de diseño para cálculos:	ASME XIII Div. 1
Presión de diseño:	10 bar
Capacidad:	6 m3
Fluido a almacenar:	Aire comprimido
Temperatura mínima/máxima funcionamiento:	-10/100 ºC

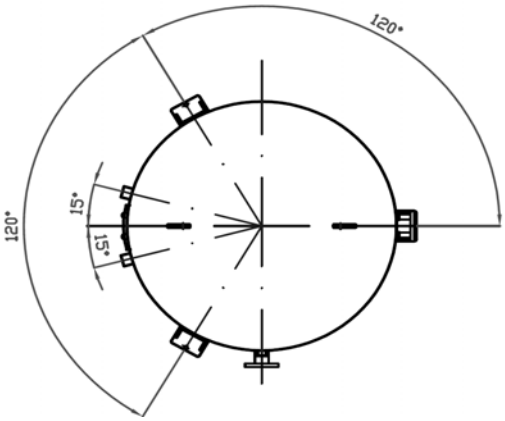
Conforme con Directiva: 97/23/CEE

Jesús Rodríguez Rodriguez

Lugar de Fabricación: Unicov

Depósito de aire





14	MANGUITO	1	1"	ST 52
13	MANGUITO	1	1/2"	ST 52
12	MANGUITO	1	2"	ST 52
11	OREJETA	2	110x120x15 mm	S355J2+N
10	SOPORTE PLACA CARACTERISTICAS	1	110 x 90x 2	S355J2+N
9	BRIDA 3" PN10	1	5"	C228 ST37.0
8	MANGUITO	1	3/4"	ST 52
7	PIE PATA	3	PIE:180x100x7 C/T Ø 22	S275JR
6	REFUERZO	3	180 x 160 x 6	S355J2+N
5	PATA	3	UPN 160x761	S275JR
4	BRIDA 3" PN10	1	5"	C228 ST37.0
3	REGISTRO	1	400x300	ST 52.3
2	VIROLA	1	4684x2847x9 mm	S355J2+N
1	F.KORBBOGEN	2	Ø1500x8.4 mm	S355J2+N
MARCA	DESCRIPCION	Nº PIEZAS	DIMENSIONES	MATERIAL

Lugar de Fabricación: Unicov

TUBERÍAS Y CONEXIONES

Códigos y normas a cumplir:

- Especificaciones de EA aplicables

  En esta planta paquete se incluirán las conexiones entre equipos de compresión y los útiles de consumo finales que requieren este aire. Para ello se dispondrá de tubería de acero sin costura de la norma DIN 2440, que se usa generalmente para conducción de gas y en especial de aire comprimido. Las longitudes serán estudiadas de acuerdo con las medidas facilitadas por el cliente donde se encuentran los útiles finales.

  Alcance de los trabajos de tuberías:

- Montaje, soldadura y canalización del aire comprimido hasta colectores de aire comprimido donde se instalarán tomas rápidas para conexión de los útiles de consumo.

- Instalación de soportes según dicte la norma vigente.

- No está incluido el montaje ni el suministro del agua.

- Se proveerá la instrumentación necesaria para el buen funcionamiento de los equipos.

OFERTA COMERCIAL

Oferta Comercial

Ref.: R-SP-11- 187

CLIENTE: RENAULT

Compresor de tornillo exento de aceite SM150 WC

Jesús Rodríguez Rodríguez
14 de octubre de 2011

Propuesta Comercial:

COMPRESORES

Cant.	Descripción	Precio unitario / Euros
2	Compresor de tornillo rotativo exento de aceite **Modelo Sierra SM150 WC** para una capacidad de **24,6 m3/min a 7 barg**, según las caracterísitcas técnicas descritas en la propuesta técnica.	**134.280 €**

SECADORES y FILTROS

Cant.	Descripción	Precio unitario / Euros
2	Secador de adsorcion **modelo D3300IL** para tratamiento de un caudal de 21,6 m3/min a 7 barg, con las características tecnicas descritas en la propuesta técnica.	**45.540 €**

TRANSPORTE

Cant.	Descripción	Precio unitario / Euros
1	Transporte de los Equipos CIP a Puerto Español. No incluye la descarga del camión.	**6.000 €**

ARRANQUE Y PUESTA EN MARCHA y FORMACIÓN DE OPERARIOS (2 días de formación)

Cant.	Descripción	Precio unitario / Euros
1	Arranque y puesta en marcha de los equipos	**DEBE CONSULTARSE CON SERVICIO TECNICO OFICIAL EN LUGAR DE DESTINO**

REPUESTOS RECOMENDADOS PARA DOS AÑOS DE FUNCIONAMIENTO

Cant.	Descripción	Precio unitario / Euros
2	Kit de repuestos recomendados para dos años de operación para los compresores S**150 WC**	**2.43 0€**
2	Kit de repuestos recomendados para dos años de operación para los el secador **D3300IL**	**890 €**

NOTA: La compañía Ingersoll Rand dispone de servicio técnico local en Venezuela, con la que se podrá realizar la puesta en marcha de los equipos, formación de operarios y mantenimiento de los equipos.

Nota:

(1) LOS PRECIOS PRESENTADOS NO INCLUYEN EL I.V.A. CORRESPONDIENTE.

EN CASO DE SER ACEPTADA NUESTRA OFERTA ROGAMOS EMITAN SU PEDIDO A LA DIRECCIÓN:

INGERSOLL RAND INTERNATIONAL LIMITED

NIF: N0071676A

C/ Tierra de Barros, 2

28823 – Coslada (Madrid)

(2) Cualquier extensión de garantía implica un seguimiento preciso por parte de los técnicos certificados de Ingersoll Rand de los programas de mantenimiento detallados por el fabricante y además el uso de repuestos originales del mismo. Tanto repuestos de mantenimiento, como los servicios en mano de obra, son siempre por cuenta del cliente o usuario y no están incluidos en esta oferta.

EXCLUSIONES DEL ALCANCE DE SUMINISTRO

Queda excluido del alcance de nuestro suministro todo aquello que no haya quedado claramente expresado en nuestra propuesta, para cualquier duda o información más detallada por favor dirigirse con nuestro delegado de zona:

- Cimientos y cualquier tipo de trabajo civil;
- Conductos de aire comprimido
- Tuberías de agua fuera de los límites ofertados para el sistema de aire comprimido
- Tuberías de drenaje desde el punto de conexión del equipo local;
- Suministro eléctrico a los motores principales y accesorios;
- Interruptor de potencia principal para el motor principal
- Válvulas fuera del sistema de aire ofertado según esquema P&ID
- Accesorios y herramientas(electricidad, aire, agua, vapor, etc.) en el lugar de emplazamiento;

- Especificaciones y normativas fuera de los estándares Ingersoll-Rand standards o cualquier procedimiento particular del cliente que no haya sido expresamente mencionado en la consulta y enviado adjunto a la misma
- Cuadros de alimentación eléctrica y proteccion eléctrica para compresores, secadores

Todas las conexiones neumáticas, hidráulicas y eléctricas efectuadas por el cliente deberán cumplir con las indicaciones contenidas en los diseños específicos y en los manuales de operación de Ingersoll-Rand.

EMBALAJE

Estándar Ingersoll Rand apropiado para transporte en camión, incluido.

PLAZO DE ENTREGA

18-20 semanas ex-Works para las máquinas **sin equipamiento opcional,** después de la recepción de su pedido oficial.

20-22 semanas CIP en Puerto Español para las máquinas **sin equipamiento opcional**, después de la recepción de su pedido oficial.

LUGAR DE ENTREGA

CIP Peninsula Iberica, descarga no incluida.

GARANTIA

12 meses desde la puesta en marcha o 18 meses desde la entrega, lo que antes ocurra.

FORMA DE PAGO

- 20 % a la firma del pedido
- 80 % a la entrega de los equipos en planta

Los pagos se ralizarán a 60 dias Fecha Factura.

VALIDEZ DE LA OFERTA

Dos meses a partir de la recepción de la oferta.

INGERSOLL-RAND INTERNATIONAL LIMITED TÉRMINOS Y CONDICIONES DE VENTA

1. DISPOSICIONES GENERALES

(a) Los Términos y Condiciones de Venta que aquí se contienen (en adelante, el "Contrato") serán de aplicación a la venta por parte de Ingersoll-Rand International Limited (en adelante, la "Compañía") a la persona, entidad o sociedad a la que se realice la oferta (en adelante el "Comprador"), de los productos equipos o piezas que dicha oferta se refiera (en adelante, el "Equipo").

(b) Si existieran discrepancias entre los términos del Contrato y los contenidos en Contrato de Distribución suscrito entre la Compañía y el Comprador, prevalecerán los términos de este último.

(c) Salvo que se acuerde por escrito lo contrario, se entenderá que la Compañía realiza los trabajos acordados procediendo según los términos y condiciones contenidos en el presente instrumento. DICHOS TÉRMINOS Y CONDICIONES PREVALECERÁN SOBRE CUALESQUIERA OTROS TÉRMINOS PROPUESTOS POR EL COMPRADOR, SALVO QUE LA COMPAÑÍA MANIFIESTE SU ACUERDO EXPRESO A LOS MISMOS. NINGÚN ACTO DE LA COMPAÑÍA PODRÁ ENTENDERSE COMO CONSTITUTUVO DE LA ACEPTACIÓN DE NINGUNO DE LOS TÉRMINOS PROPUESTOS POR EL COMPRADOR. Las Condiciones de Pago se entenderán, salvo que las partes acuerden lo contrario por escrito, en metálico neto, a pagar en su totalidad a la entrega. Todos los precios están sujetos a modificaciones para su adecuación a los precios vigentes a la fecha de la entrega. La Compañía tendrá derecho a modificar sus precios en cualquier momento. Todos los precios son FCA (Incoterms 2000), salvo que se indique lo contrario. Los precios no incluirán los costes de embalajes especiales, seguros, tasas o aranceles extranjeros, o cualesquiera otros cargos que pudieran resultar aplicables a la importación o exportación del Equipo. En caso de que se pacten condiciones de pago Incoterms distintas del FCA, se aplicará un incremento sobre el precio del Equipo para cubrir los costes extras. Todo coste extra se reflejará en la factura enviada al Cliente. La Compañía podrá remitir al Comprador sus facturas, declaraciones o reconocimientos exclusivamente por vía electrónica, incluyendo el correo electrónico con archivos adjuntos. Nada de lo previsto en el presente contrato podrá afectar a los derechos legales del consumidor.

(d) La Compañía se reserva el derecho a liquidar intereses al tipo anual de EURIBOR (Euro InterBank Offered Rate) más cinco (5%) por ciento sobre las cantidades totales adeudadas, intereses que se acumularán diariamente.

(e) En el caso de pago a plazos, el impago de alguno de los plazos implicará que todas las demás cantidades pagaderas en virtud del presente Contrato devendrán de forma inmediata líquidas y exigibles.

(f) Si alguna de las disposiciones del presente Contrato fuera declarada nula o ineficaz, la misma se entenderá suprimida del contrato, si bien el resto de las cláusulas que componen el mismo seguirán siendo plenamente eficaces. Si se entendiera que el Contrato está incompleto, la cláusula o disposición suprimida será sustituida de forma automática por aquélla que más se acerque al objetivo económico del Contrato.

(g) El Comprador deberá notificar a la Compañía cualquier error que observe en las facturas en el plazo de siete (7) días desde su recepción. El incumplimiento de dicha comunicación significará que el Comprador entiende aceptables y correctos los términos de la factura en todos sus extremos. No obstante lo anterior, cuando exista un error en el precio y la Compañía comunique dicho error al Comprador, antes o después del envío, el Comprador abonará el precio correcto del Equipo.

2. TITULARIDAD

La titularidad legal, derecho de posesión y control, propiedad y demás potestades derivadas de la misma (en adelante, la "titularidad") serán transmitidas al Comprador de la forma siguiente:

(a) Hasta el pago total de todas las cantidades adeudadas a la Compañía tanto en virtud del acuerdo como por cualquier otra causa (o, si la Compañía hubiera aceptado un cheque, letra de cambio o cualquier otro efecto mercantil, hasta la satisfacción del mismo):

(i) La Compañía conservará la titularidad de los Productos suministrados, aun cuando hayan sido instalados o incorporados de cualquier otra forma a otros bienes del Comprador o de un tercero.

(ii) El Comprador tendrá total libertad para vender los Productos a precio de mercado como parte principal de su actividad mercantil. En el caso de que la Compañía tenga motivos para pensar que el Comprador pretende designar un administrador, liquidador o síndico o amenace con nombrarlo, o celebre cualquier tipo acuerdo de naturaleza análoga con la mayoría de sus acreedores, la Compañía podrá retener el producto de las ventas en su totalidad, siempre que haya comunicado por escrito al Comprador el término de su capacidad de disposición para la venta; en cualquier momento tras la comunicación del fin de la capacidad de disposición para la venta, la Compañía podrá recobrar la posesión de los Productos cuya titularidad no haya sido transmitida al Comprador.

(iii) La Compañía, sus agentes y sus empleados tendrán el derecho irrevocable a entrar en las instalaciones del Comprador para inspeccionar o recobrar tales Productos o parte de ellos.

(b) Hasta la transmisión de la titularidad de los Productos al Comprador, éste deberá conservar los mismos en concepto de fideicomiso y como depositario de la Compañía; almacenar los Productos de forma independiente del resto Equipo del Comprador o de un tercero, de forma que resulten perfectamente identificables como propiedad de la Compañía, sin coste alguno para ella; abstenerse de destruir, deformar u oscurecer las marcas identificativas o relativas a los Productos, o su embalaje; y mantener los Productos asegurados de forma satisfactoria frente a cualquier riesgo, en nombre de la Compañía y por su valor total, debiendo facilitar a la Compañía en cualquier momento y a su solicitud una copia de la póliza suscrita.

(c) En caso de que las cantidades adeudadas a la Compañía fueran satisfechas antes de la entrega de los Productos, la titularidad de los mismos se transmitirá en el momento de su descarga en el puerto correspondiente del país de destino, o, si se hubiera pactado otra forma de transporte, en el momento en que llegue al primer punto de entrada o aduana del país de destino.

(d) La Compañía tendrá derecho a recuperar las cantidades pagadas por los Productos siempre que no haya transmitido la titularidad de los mismos.

3. RIESGO

El Comprador asumirá el riesgo de pérdida del Equipo desde el momento del primer intento de envío al Comprador, su representante o transportista, aun cuando la propiedad del mismo no haya sido transmitida según lo previsto en el artículo 2 del presente contrato. El cumplimiento estricto de los términos del presente apartado es una condición previa para poder derivar la responsabilidad contemplada en este Artículo 3 a la Compañía.

4. CESIÓN

El Comprador no podrá ceder o transferir el presente Contrato sin el previo consentimiento expreso de la Compañía. La Compañía podrá ceder o transferir el presente Contrato sin necesidad de consentimiento previo, pudiendo asimismo ceder o transmitir su derecho a percibir todo o parte del precio adeudado por el Comprador en virtud del presente Contrato sin el consentimiento de éste.

5. TRANSPORTE

(a) Salvo que el Comprador especifique otra cosa, la Compañía elegirá la forma de transporte, incluyendo, caso de ser necesario, el lugar o lugares de almacenamiento, de conformidad con las condiciones de envío vigentes en el momento del envío o durante el mismo. A solicitud del Comprador, la Compañía obtendrá espacio de flete marítimo, seguro marítimo (que incluirá desde el almacén estándar hasta la cobertura de almacén), seguro de riesgo de guerra y servicios de agencia de transportes, siendo todos los gastos de cuenta del Comprador.

(b) Todos los envíos se realizarán por cuenta del Comprador. Si los envíos se retrasaran como consecuencia de retrasos en el pago, o por la tardanza por parte del Comprador en dar las pertinentes instrucciones de envío o porque éstas fueran incompletas, serán de cuenta del Comprador los costes de almacenamiento que se generen desde el momento en que la Compañía comunique que el Equipo solicitado está preparado para su envío; en el caso de que el Equipo estuviera almacenado en instalaciones de la Compañía, el Comprador satisfará por tal concepto una cantidad mínima igual a la mitad del uno por ciento mensual del importe facturado.

(c) Podrán realizarse envíos parciales debiendo realizarse el pago de los mismos de conformidad con los términos aquí estipulados, a medida que se efectúen los envíos y se emitan las facturas.

(d) El Comprador deberá realizar las reclamaciones por defecto en la cantidad de las mercancías dentro de los dos (2) días siguientes a la recepción de los productos.

6. ENTREGA Y RETRASOS

Las fechas de entrega son estimativas, no pudiendo en ningún caso ser interpretadas como “condición esencial” o de cualquier otra forma igual de amplia o con análogos efectos legales. La Compañía no será responsable de la pérdida, daños, retención, retraso o pérdida de una orden como consecuencia de actos divinos, actos de terrorismo, guerra, disturbios, insurrección civil, huelgas o paros laborales, incendios, accidentes, actos de la autoridad civil o militar, incluyendo la normativa estatal, embargos, decomisos, prioridades o reglamentos, retraso en el transporte, escasez, retraso en el suministro de los materiales, actos del Comprador o cualquier otra causa que escape razonablemente al control de la Compañía. La aceptación del envío constituye una renuncia a cualesquiera reclamaciones por los daños causados por el retraso en la entrega.

7. IMPUESTOS

El Comprador deberá satisfacer el IVA o cualesquiera otros impuestos sobre ventas, así como las tasas y aranceles de la naturaleza que sean, que graven el precio de compra del Equipo, salvo que se acuerde otra cosa.

8. PAGO

(a) El Comprador acuerda no practicar deducción o retención alguna sobre las cantidades adeudadas a la Compañía con ocasión de la venta del Equipo, salvo que la Compañía haya emitido una nota de crédito por la cantidad de dicha deducción o retención.

(b) El pago deberá realizarse en la moneda reflejada en la orden de compra o en la factura.

9. PATENTES

La Compañía asumirá la defensa de cualquier acción legal o procedimiento iniciado contra el Comprador, y abonará cualquier cantidad a la que el mismo hubiera sido condenado en el curso de dicha acción o procedimiento, cuando éste tenga su causa en una reclamación basada en la infracción, con el uso de los Equipos fabricados por la Compañía y suministrados en virtud del presente Contrato, de cualquier patente de un país en el que se vendan los Equipos, o de un país en el que la Compañía tenga conocimiento de que los Equipos están siendo utilizados a la fecha de la venta, siempre que la Compañía reciba notificación inmediata y por escrito al respecto y se le proporcionen facultades, información y asistencia para dicha defensa. En caso de que se presente una reclamación por infracción, la Compañía podrá, a su simple criterio, recabar para el Comprador el derecho a continuar utilizando dicho Equipo, modificarlo de forma que deje de incurrir en una infracción, sustituirlo por otro que no constituya infracción, o retirarlo y devolver el precio de compra.

La presente disposición no se entenderá en ningún caso constitutiva de acuerdo alguno en cuya virtud la Compañía acepte responsabilidad alguna en relación con invenciones que incluyan más que los Equipos suministrados en virtud del presente Contrato, o con respecto a patentes sobre métodos y procesos que deban desarrollarse con la ayuda de dichos Equipos. La anterior disposición recoge la responsabilidad completa de la Compañía en relación con la infracción de patentes, limitada por la Cláusula 12 subsiguiente.

10. ESPECIFICACIONES Y MEJORAS

Salvo que se acuerde expresamente lo contrario, las especificaciones de la Compañía relativas a los Equipos podrán ser objeto de modificación por parte de la Compañía durante su fabricación sin necesidad de comunicación previa al Comprador. La Compañía sigue una política de esfuerzo constante para mejorar sus Equipos. Por ello, la Compañía se reserva el derecho a introducir cambios en el diseño, o de cualquier otro tipo, cuando considere que constituyen una mejora para los Equipos, pero sin estar por ello obligada a introducir dichos cambios con efectos retroactivo.

11. GARANTÍAS

(c) Salvo que de la documentación de la garantía se deduzca otra cosa, la Compañía garantiza, a través del Comprador, (a) que el Equipo vendido no presenta defecto alguno en los materiales ni en la mano de obra, durante un periodo de doce (12) meses desde la fecha de envío; (b) que las piezas

vendidas no presentan defecto alguno en los materiales ni en la mano de obra, por un periodo de seis (6) meses desde la fecha de envío; y (c) que las piezas reparadas no presentan defecto alguno ni en los materiales ni en la mano de obra, por un periodo de tres (3) meses.

(d) Dentro de los plazos establecidos en el apartado anterior, la Compañía suministrará una pieza nueva o reparada, a su elección, en sustitución de cualquier pieza que se estime tras su inspección defectuosa en los materiales o en la mano de obra. A elección de la Compañía, dicha pieza podrá ser reparada o sustituida sin cargo alguno para el usuario inicial, quien deberá exhibir la prueba de compra (y acreditar la fecha de la misma) a la hora de realizar su reclamación con base en la presente garantía. Esta garantía no será de aplicación a defectos que tengan su causa en una utilización abusiva o incorrecta, reparaciones negligentes, corrosión, erosión, deterioro normal por el uso, alteraciones o modificaciones realizadas en el producto sin el consentimiento expreso de la Compañía, o en el incumplimiento de las prácticas de manipulación recomendadas o de los procedimientos de mantenimiento y conservación previstos en la documentación sobre manipulación y mantenimiento del producto. Los trabajos de mantenimiento, conservación y reparación deberán ser realizados por un distribuidor autorizado de la Compañía o por un establecimiento autorizado; en tales trabajos sólo podrán utilizarse piezas originales aprobadas por la Compañía. La inobservancia de las condiciones aquí establecidas dejará sin efecto la presente garantía.

(e) La garantía aquí descrita no será de aplicación a los motores y mecanismos fabricados por terceros, los cuales dispondrán de la garantía correspondiente prestada directamente al usuario inicial por sus respectivos fabricantes.

(f) LA COMPAÑÍA EXCLUYE CUALESQUIERA OTRAS CONDICIONES, GARANTÍAS O DECLARACIONES DE CUALQUIER OTRA NATURALEZA, EXPRESAS O IMPLÍCITAS, LEGALES O DE CUALQUIER OTRO TIPO (EXCEPTO LAS RELATIVAS A LA TITULARIDAD), INCLUYENTO TODAS LAS GARANTÍAS IMPLÍCITAS Y CONDICIONES RELATIVAS A LA APTITUD PARA LA VENTA, SATISFACCIÓN CON LA CALIDAD Y ADECUACIÓN DEL EQUIPO PARA UN DETERMINADO FIN.

(g) CON LAS CORRECCIONES REALIZADAS POR LA COMPAÑÍA EN RELACIÓN CON FALTAS DE CONFORMIDAD, PATENTES O LATENTES, EN LA FORMA Y TIEMPO ANTERIORMENTE PREVISTAS, LA COMPAÑÍA HABRÁ DADO CUMPLIMIENTO A TODAS SUS RESPONSABILIDADES RELATIVAS A TALES FALTAS DE CONFORMIDAD, TANTO SI ESTAS TIENEN SU BASE EN EL CONTRATO, GARANTÍA, ACTOS ILÍCITOS O NEGLIGENTES, INDEMINIDAD, RESPONSABILIDAD LIMITADA O EN CUALQUIER OTRA CAUSA RELACIONADA O RELATIVA AL PRODUCTO.

(h)

(i) LIMITACIÓN DE RESPONSABILIDAD

(j) Los recursos con que cuentan las partes se recogen en el Contrato.

(k) LA COMPAÑÍA (O SUS ENTIDADES ASOCIADAS, FILIALES, DEPENDIENTES O MIEMBROS DEL GRUPO) NO SERÁ RESPONSABLE ANTE EL COMPRADOR O SUS CLIENTES POR EL LUCRO CESANTE, PÉRDIDA DE INGRESOS O DE VOLUMEN DE NEGOCIO, PÉRDIDA DE FONDO DE COMERCIO O POR CUALQUIER OTRA PÉRDIDA O DAÑO ESPECÍFICO, INCIDENTAL, INDIRECTO O DERIVADO, DE LA NATURALEZA QUE SEA, TANTO SI TIENE SU ORIGEN EN UN ACTO ILÍCITO (INCLUYENDO LA NEGLIGENCIA) O EN EL INCUMPLIMIENTO DEL CONTRATO COMO EN CUALQUIER OTRA CAUSA, RELACIONADO CON EL CONTRATO O CON ACUERDOS COMPLEMENTARIOS, O CON EL PRODUCTO O PIEZAS SUMINISTRADAS EN VIRTUD DEL PRESENTE INSTRUMENTO, TENIENDO EN CUENTA QUE NADA DE LO PREVISTO EN EL PRESENTE ACUERDO EXCLUYE O LIMITA LA RESPONSABILIDAD DE LA MISMA (O DE SUS ENTIDADES ASOCIADAS, FILIALES, DEPENDIENTES O MIEMBROS DEL GRUPO) POR FRAUDE, DAÑOS PERSONALES O FALLECIMIENTO CAUSADO POR SU NEGLIGENCIA.

(l) SIN PERJUICIO DE LO DISPUESTO EN EL APARTADO 12(B), Y NO OBSTANTE LA INVALIDEZ O INEFICACIA DE ALGUNA DE LAS DISPOSICIONES DEL PRESENTE ACUERDO, LA RESPONSABILIDAD MÁXIMA DE LA COMPAÑÍA (O DE SUS ENTIDADES ASOCIADAS, FILIALES, DEPENDIENTES O MIEMBROS DEL GRUPO) FRENTE AL COMPRADOR Y/O SUS CLIENTES, CON OCASIÓN DEL PRESENTE CONTRATO Y DE CUALQUIERA DE LOS PRODUCTOS O PIEZAS SUMINISTRADOS EN VIRTUD DEL MISMO, NO EXCEDERÁ, POR CADA SINIESTRO O SERIE DE SINIESTROS RELACIONADOS, DEL PRECIO DE COMPRA DEL PRODUCTO SOBRE CUYA BASE DE DETERMINE LA RESPONSABILIDAD, Y ELLO CON INDEPENDENCIA DE QUE LA MISMA TENGA SU CAUSA EN EL CONTRATO, EN UNA ACTUACIÓN ILÍCITA (INCLUYENDO LA NEGLIGENCIA) O EN CUALQUIER OTRA CIRCUNSTANCIA.

(m) Ni el Comprador ni ninguna sociedad filial o cesionaria de la misma tendrá derecho a compensación alguna, salvo que se estipule lo contrario

(n) Las disposiciones del presente Artículo 12 seguirán siendo aplicables tras la terminación del Contrato.

12. CONFORMIDAD

El Comprador no podrá vender, exportar o re-exportar el Equipo, ni directa ni indirectamente, a personas o territorios prohibidos por las normas que regulan la exportación en los Estados Unidos de América o en la Unión Europea, o por cualquier otra normativa sobre exportación que resulte aplicable.

13. INFRACCIÓN DE LA LEY

La Compañía no vendrá obligada a suscribir ninguna condición o disposición de una orden de compra, presupuesto, oferta, carta de crédito o documento de análoga naturaleza, ni ninguna disposición legal o práctica que pudiera implicar el incumplimiento por parte de la Compañía, su matriz o cualquiera de sus filiales, de las leyes de exportación, de la legislación fiscal, o de la normativa del país en el que se fabrican los Equipos o desde el que se exportan o a cuya jurisdicción estén sujetos.

14. RESPONSABILIDAD NUCLEAR

En caso de que los Equipos vendidos en virtud del presente contrato vayan a ser utilizados en una planta nuclear, el Comprador y/o el Propietario de la planta eximen de toda responsabilidad y acuerdan indemnizar a la Compañía y a sus proveedores por cualesquiera daños nucleares que se produzcan tanto dentro de la planta como fuera de la misma, incluyendo la pérdida de uso, y tengan su causa en un accidente nuclear, aun cuando se aleguen causados en todo o en parte por una actuación negligente o de cualquier otro tipo de la Compañía o de sus proveedores.

15. SISTEMA ELECTRÓNICO DE PEDIDOS

En el caso de que la presente venta se haya conluido a través del sistema electrónico de pedidos de la Compañía (el “Sistema”), serán de aplicación las siguientes condiciones:

(a) La utilización del Sistema precisará el suministro de una contraseña de usuario por parte de la Compañía, así como de cualquier otra medida de seguridad que se considere oportuna. El Comprador se compromete a mantener en secreto su contraseña de usuario y las demás medidas de protección en su caso facilitadas, y a no revelarlas a nadie que no esté autorizado para acceder al Sistema. El Comprador será responsable ante la Compañía del acceso o utilización del Sistema no autorizado.

(b) Toda la información suministrada al Comprador a través del acceso para la utilización del Sistema tiene carácter Confidencial y no podrá ser comunicada a ningún tercero que no haya sido autorizado por la Compañía.

(c) En la medida en que la información introducida por el Comprador en el Sistema tenga carácter personal, tal información deberá ser procesada de conformidad con la legislación sobre Datos de Carácter Personal aplicable a la misma. Los datos personales podrán ser compartidos con terceros,

pudiendo ser objeto de cesión dentro del territorio del Espacio Económico Europeo y fuera del mismo, manifestando expresamente el Comprador su consentimiento a dicha cesión.

16. JURISDICCIÓN Y LEY APLICABLE

(o) La Compañía y el Comprador manifiestan de mutuo acuerdo que el presente contrato ha sido celebrado en Irlanda, y que habrá de interpretarse y estar sometido a la legislación irlandesa.

(p) La Compañía y el Comprador convienen excluir expresamente la aplicación de la Convención de las Naciones Unidas sobre Venta Internacional de Mercancías al presente Contrato.

(q) Con sujeción a lo previsto en el apartado (d) subsiguiente, la Compañía y el Comprador acuerdan de forma irrevocable someter cualquier cuestión o procedimiento judicial relativo al presente Contrato (incluyendo, entre otros, cualesquiera discrepancias sobre la existencia, validez o terminación del presente Contrato) a la jurisdicción de los tribunales de Irlanda, renunciando expresamente el Comprador a formular cualquier excepción por incompetencia o falta de jurisdicción.

(r) No obstante lo dispuesto en el apartado (c) precedente, la Compañía y el Comprador reconocen que el apartado (c) opera únicamente en beneficio de la Compañía, y que, en consecuencia, la misma tendrá derecho a incoar el procedimiento ante cualquier otro juzgado o tribunal que tenga jurisdicción.

17. EJECUCIÓN

La Compañía no estará vinculada a contrato o modificación alguna hasta su aprobación por escrito por parte de alguno de sus directivos. Una vez aprobado de tal forma, el Contrato sustituirá a toda comunicación anterior, verbal o escrita

IMPACTO AMBIENTAL

7.5.1 Objeto

En este apartado se identificarán las posibles influencias que se tendrían sobre el medio ambiente y las situaciones correctoras que lo acontecen en el proyecto.

7.5.2 Ruidos y vibraciones

Los equipos de compresión y el de refrigeración de agua producen vibraciones que son transmitidas directamente al suelo.

La actividad no podrá emitir al exterior, con exclusión del ruido de fondo

(tráfico o fuente ruidosa natural), un nivel de emisión al exterior N.E.E. superior al expresado en la tabla nº 2 del Anexo III del Reglamento de Calidad del Aire.

Este valor de N.E.E. es de 75 dB(A) en horario de 7,00 a 23,00 h. y 70 dB(A)

en horario de 23,00 a 7,00 h, para zonas con residencia.

Se prevé un horario de actividad de 24 horas.

Según especificaciones de Empresarios Agrupados ningúno de los equipos ha de superar el límite sonoro de 85 Db a 1 metro del equipo, esta cantidad sólo es se vería superada por el equipo de refrigeración de agua. Por este motivo IR excluye de su oferta dicho aparato, asegurando un menor valor de 70 Db en el exterior.

En lo referente a la transmisión de vibraciones se considera que la actividad

no posee un gran valor a considerar, aún así se han de disponer como recomendación que atenuen dichas vibraciones bancadas de hormigón para los elementos que irán anclados con pernos de anclaje al suelo.

7.5.3 Emisiones a la atmósfera

La actividad de producción de aire comprimido no lleva implícita ninguna emisión de gases a la atmósfera.

7.5.4Utilización de agua y vertidos líquidos

El único vertido líquido producido es el agua producido por los condensados de los equipos, y este es completamente libre de aceite, con lo que no necesita tratamiento posterior, o separador agua-aceite.

En cuanto a la utilización del agua de refrigeración, el agua con la que se rocía

deberá ser cambiada cada 6 meses de utilización acorde con el manual de

mantenimiento y operación del suministrador del equipo.

En cuanto al agua de refrigeración de los compresores cada 2000 horas se debe hacer una prueba (realizada por el suministrador de los equipos) como mantenimiento preventivo tal y como se muestra en el manual de operación y mantenimiento.

El aceite de lubricación de los compresores ha de ser inspeccionado mediante prueba química cada 2000 horas y cambiado en caso de no superar la prueba. Este aceite será recogido por el suministrador que se hará cargo de reutilizarlo o tratarlo.